COMPUTER METHOD FOR SUBDIVISION PLANNING, DESIGN, AND MAPPING

By

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NOMENCLATURE

$A_{YG,XG,1}$	elevation of a grid point on the vertical control grid at location XG,YG
$A_{YG,XG,2}$	qualitative fact, a grid point on the vertical control grid at location XG,YG
ARC_{i-j-k}	length of an arc from point i to point k, i, j, and k, being the PC, center of curvature, and PT, respectively
$AREA_{i-...-m}$	area of a traverse containing points i, . . ., m
$B_{i,1}$	east (X) coordinate of a random input point i
$B_{i,2}$	north (Y) coordinate of a random input point i
$B_{i,3}$	elevation of random input point i
$B_{i,4}$	qualitative fact about random input point i
$C_{i,1}$	correction of the east (X) coordinate of point i
$C_{i,2}$	correction of the north (Y) coordinate of point i
CH_{i-j-k}	length of the long chord of a curve defined by points i, j, and k
$DIST_{i-j}$	horizontal distance between points i and j
DMD_{j-k}	double meridian distance of a line defined by points j and k in a traverse containing points i, j, k, . . ., m, being twice the sum of all ΔE's occurring before the line defined by points j and k plus ΔE_{j-k}
$DIST_{(YG,XG)-i}$	horizontal distance between a grid point at location XG,YG and a random input point i
$DIST_{(YG,XG)-o}$	horizontal distance between a grid point at location XG,YG and the origin
$EL_{contour}$	elevation of a contour line to be plotted
EL_{max}	elevation of the highest random input point
EL_{min}	elevation of the lowest random input point

EX	vertical exaggeration factor used in three-dimensional pictures
i, j, k, l, m	points (given integer labels)
n	number of points in a traverse
RAD_{i-j-k}	radius of a curve defined by points i, j, and k
$S_{i,1}$	east (X) coordinate of point i
$S_{i,2}$	north (Y) coordinate of point i
$S_{i,3}$	qualitative fact concerning point i
SCF	scale factor used in plotting; usually the plot is drawn at a scale of 1 inch = SCF (feet of meters)
SH	shrink factor used to allow three-dimensional pictures to fit on the eighteen-inch plot
TAN_{i-j-k}	tangent length of the curve defined by points i, j, and k
XG	X (east) location on the vertical control grid
YG	Y (north) location on the vertical control grid
XG+1	location XG on the vertical control grid plus one grid location to the east (X)
YG+1	location YG on the vertical control grid plus one grid location to the north (Y)
XPEN	X location on the plot in inches for the next pen movement
YPEN	Y location on the plot in inches for the next pen movement
α_{i-j}	angle which is the arctangent of $(\Delta N_{i-j} + \Delta E_{i-j})$; may be the bearing angle of the line defined by points i and j, if so noted
α_{i-j-k}	interior angle at point j defined by points i, j, and k
α_{i-o}	interior angle defined by the positive x axis, the origin, and point i
$\alpha_{(direction)}$	given angle in surveying and the direction (right, left, deflection right, deflection left) of the angle
β	rotation angle used in three-dimensional plotting

γ	altitude angle used in three-dimensional plotting
δ_{i-j-k}	deflection angle per foot of arc in minutes of a curve defined by points i, j, and k
Γ_1	grade of a vertical tangent approaching a vertical curve
Γ_2	grade of a vertical tangent following a vertical curve
ΔE_{i-j}	horizontal distance between the east (X) coordinates of points i and j
ΔEL_{i-j}	change in elevation between vertical points i and j
ΔN_{i-j}	horizontal distance between north (Y) coordinates of points i and j
ΣN	north (Y) increment used in profile plotting
ΣE	east (X) increment used in profile plotting

CHAPTER I

INTRODUCTION

As cities around the world continue to grow, many more housing areas must be incorporated within or around them. Many areas have planning laws and ordinances governing additions to cities. For example, when a parcel of land is reduced into lots, or subdivided, it may be required that each lot have access to streets and utilities, that all distances and bearings close in all directions horizontally, and that the areas of all divisions or lots be calculated.

In addition to many of the traditional considerations of housing subdivision design such as horizontal closure, street and sewer grades, water lines and access to other utilities, other considerations such as new subdivision and platting regulations, and site planning standards such as soil type, vegetation, hydrology, topography, optimum solar and wind orientation, surface water retention, and existing surveying systems of the area must be investigated.

Each of the considerations listed above requires many man-hours of time to be adequately investigated. This has the effect of unnecessarily driving up the cost of housing subdivision design, or reducing the profits of the consulting engineer or the subdivision designer.

The objective of this research was to investigate the applications of the digital computer to the various housing subdivision design criteria, and to design and implement a computer program which would aid a consulting engineer in the various aspects of housing subdivision design.

CHAPTER II

LITERATURE REVIEW

Subdividing and Platting Lands

The art and science of surveying and subdividing land is thousands of years old. According to Kissam (1979), the ancient Egyptians had a command of surveying, as evidenced in the Great Pyramid of Khufu at Giza, which was built about 2700 B.C. It was exactly 755 feet long and 480 feet high, accurately square and perfectly oriented to the cardinal points of the compass. The Egyptians are also credited with developing the surveying techniques necessary for property and boundary surveying. On the wall of a tomb at Thebes (built about 1400 B.C.), a head and rear chairman are pictured measuring a grainfield with what appears to be a rope with knots or marks at uniform intervals. The annual flooding on the Nile necessitated some system for reproducing obliterated lines and corners (Bouchard 1979), hence much of the early mathematics and surveying techniques were developed.

Among the first articles in English literature concerning the subdivisions of land was an article by Agas (1596). In "A Preparative to Platting of Lands and Tenements for Surveigh" he discusses the accuracy of various surveying instruments used for platting in the field.

> . . . I have seen several measurements taken by the plain table, and set down particularly under several men's hands, differing fifteen acres, from the most to the least, in the sum of one hundred and twenty, valued and sold at nine pounds, and ten shillings, for every acre. . . . (p. 7)

> . . . And now to the theodolite: It carries in itself all manner of angles, measures, numbers and proportions, . . . It enforceth ground in what quantity ever, . . . varying against the same anyway at your pleasure, so full and exactly . . . Enter then your practice for a country manner, lordship, etc. in the middle, or where best you like, observe, and quote your angles every way as they light: sometime half a dozen at a station, more or less, and follow for your most advantage. (pp. 8-9)

Concerning the subdividing and platting of lands,

> . . . If you will sever any field or close into two or more parcels . . . the survey by plat . . . shall be for continual evidence, and perpetual preservation of all lands and tenements, unto the owners thereof, that are contained and set down in the same. And therefore, upon the perfecting of any such survey, you may make a fair parchment book with a large margin, you may enter and engrave the same from the said plat, and give it date accordingly . . . About twenty years hence, in the controversy for a sheep's course or walk, (the) map may be employed for laying out . . . the circuit and bounds of the same course. (pp. 15-16)

Clearly, the subdivision and development of lands cannot take place without some form of regulation. Community Planning Associates (1976) defines sub-division control as

> . . . Local ordinances which typically have controlled the physical layout of new areas (size of lots, width of streets, building lines, street contours, etc.). Increasingly, they are also requiring the provision of utilities and other basic improvements, such as open space, parking areas, shopping centers, and school sites. (p. 76)

Subdivision regulations apply to previously undeveloped areas which are being developed for homes. These regulations are a form of consumer protection for the home buyer, assuring adequate streets, sewers, and water supply, as well as provisions for parks and schools (Community Planning Associates, 1976).

The general nature of subdivision regulations may serve a wide range of purposes. To the health officer they are a means of insuring that new residential developments have a safe water supply and sewage disposal

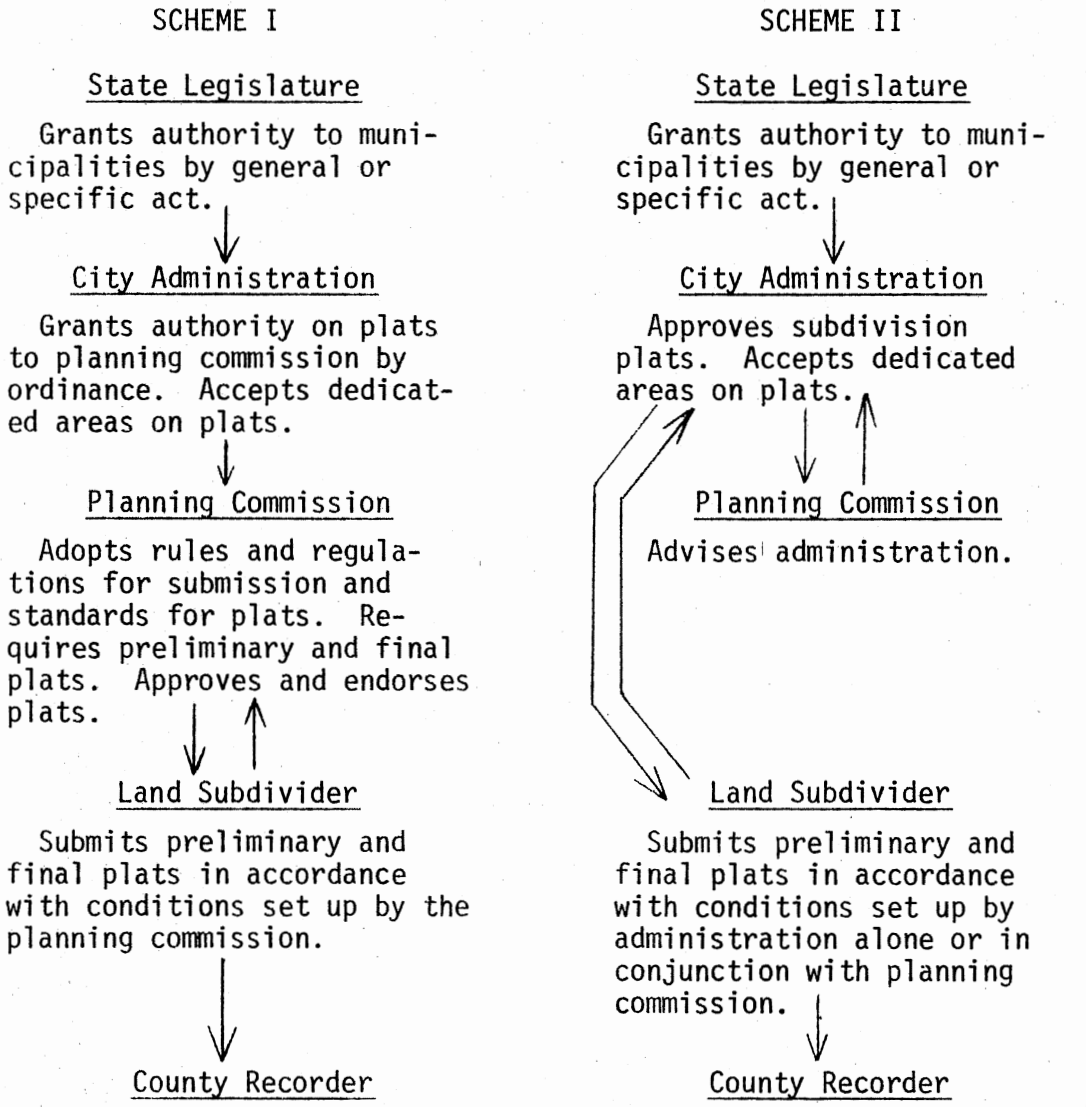
system, as well as providing a record of the location of underground utilities (Goodman et al., 1968).

According to Lautner (1941), the authority or the regulation of platting is usually held on the local level. In most states, approval by a local agency is required before a plat may be recorded. The approving authority is usually a city planning commission, city-county planning commission, the local legislative body (such as a city commission), the city engineer, or a combination of the above. Figure 1 depicts two common approval schemes.

In order to satisfy the regulations for subdivision design and to avoid omissions, an outline of certain site planning standards should be followed. According to DeChiara and Koppelman (1978), a site inventory including soils, vegetation, hydrology, climate, and existing land use, as well as the survey system of the area (metes-and-bounds or rectangular), geology, and topography should be made. A preliminary plat including grading, earthwork, drainage (erosion), and street and utility location may then be made. If available, a preliminary graphic analysis of topography (see Figure 2) is helpful.

More specific considerations, such as climate conditions, flood plain classification, specific drainage plans, water supply, sewage removal, and final site selection for single and multifamily housing, schools, parks and green belts, solar orientation, wind orientation, noise, traffic, spatial structure, and landscaping are then made. Figure 3 illustrates the various phases of site planning from the end of the preliminary investigation through final plat for a housing subdivision.

Vogel (1965) describes certain design considerations in the subdi-



Source: Harold W. Lautner, Subdivision Regulations (1941).

Figure 1. Two Methods of Housing Subdivision Planning Authority

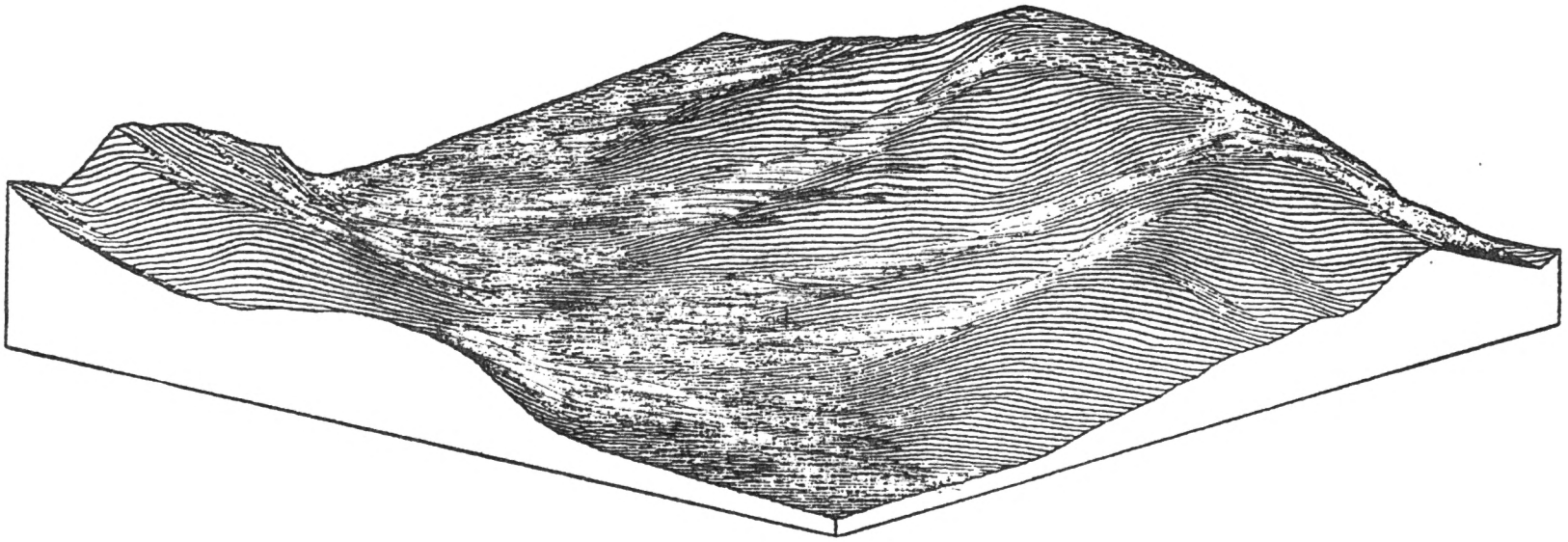
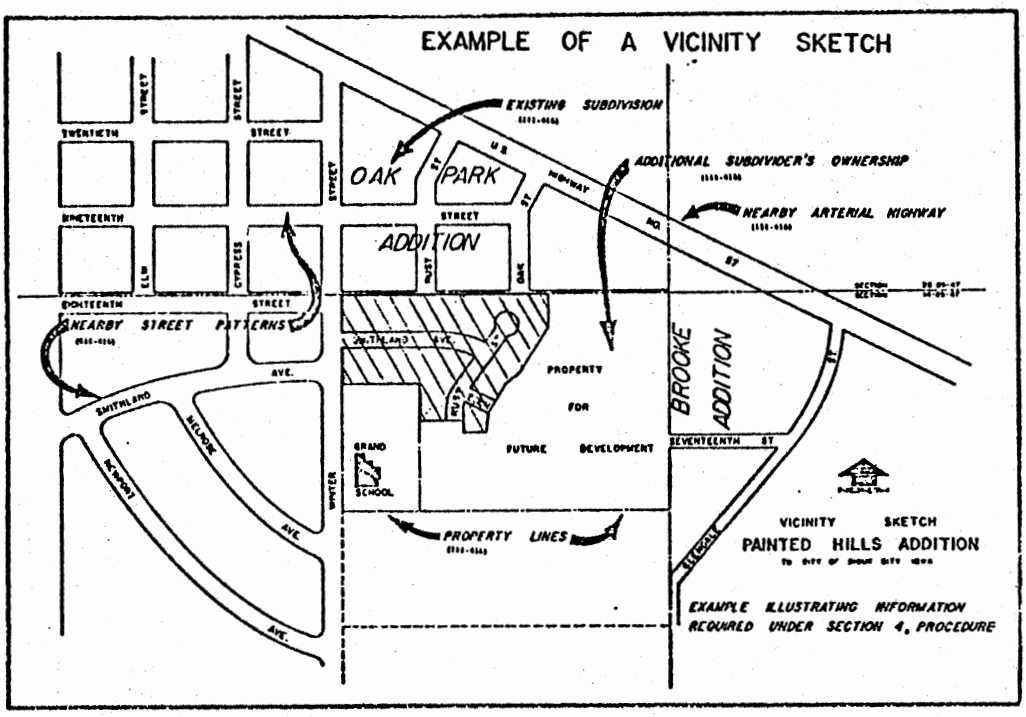
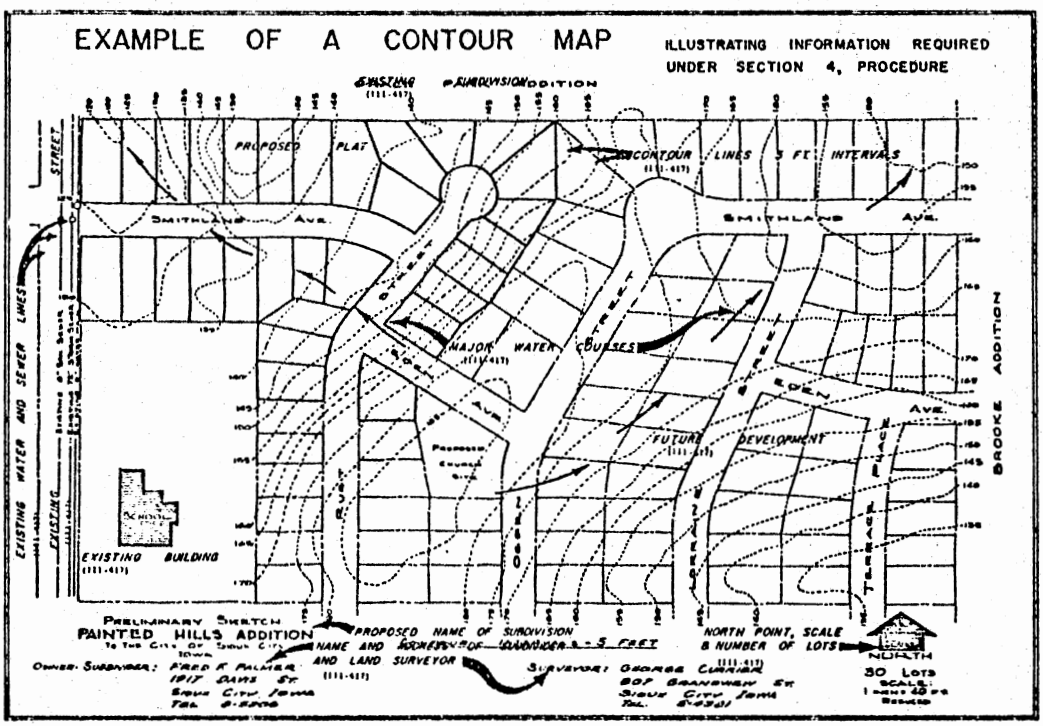


Figure 2. Isometric and Topographic Computer Representation of Subdivision Areas

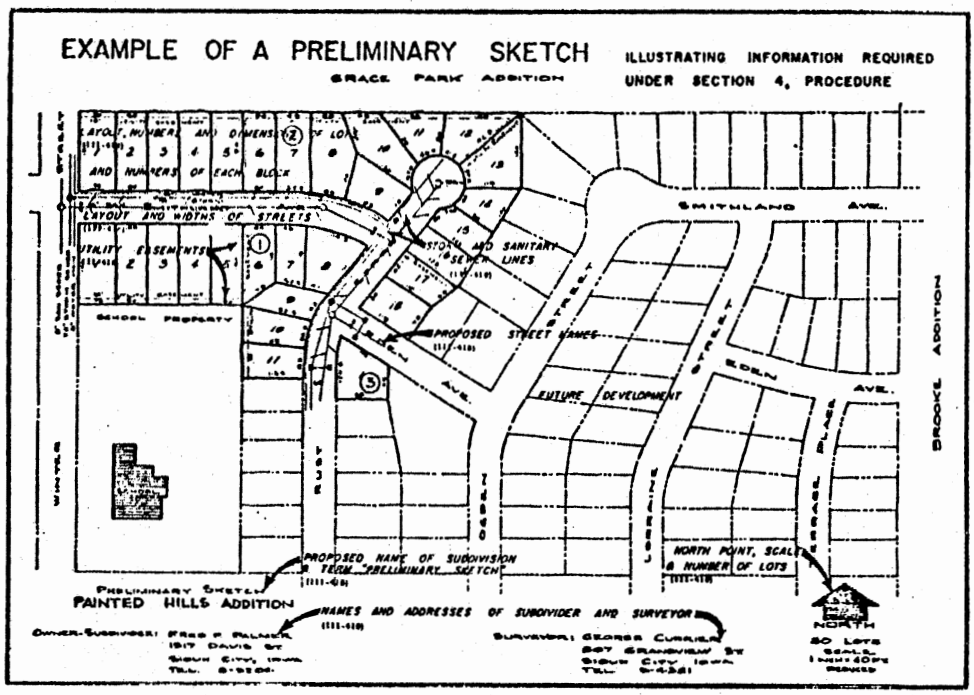


(a) Example of a Vicinity Sketch

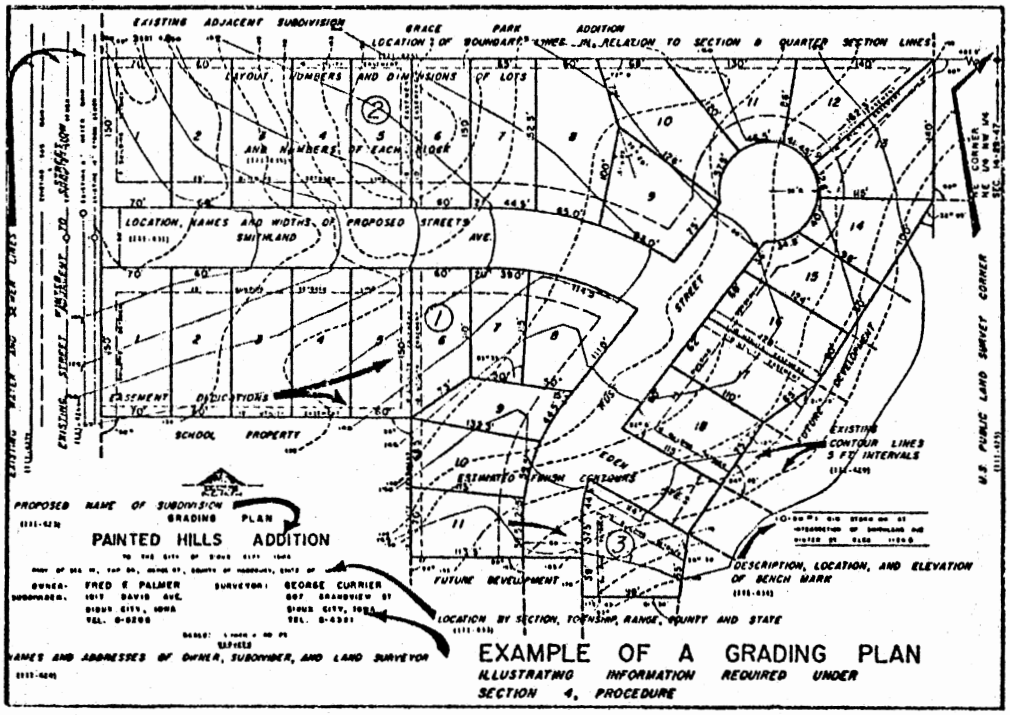


(b) Example of a Contour Map

Figure 3. Development of a Site Plan for a Housing Subdivision

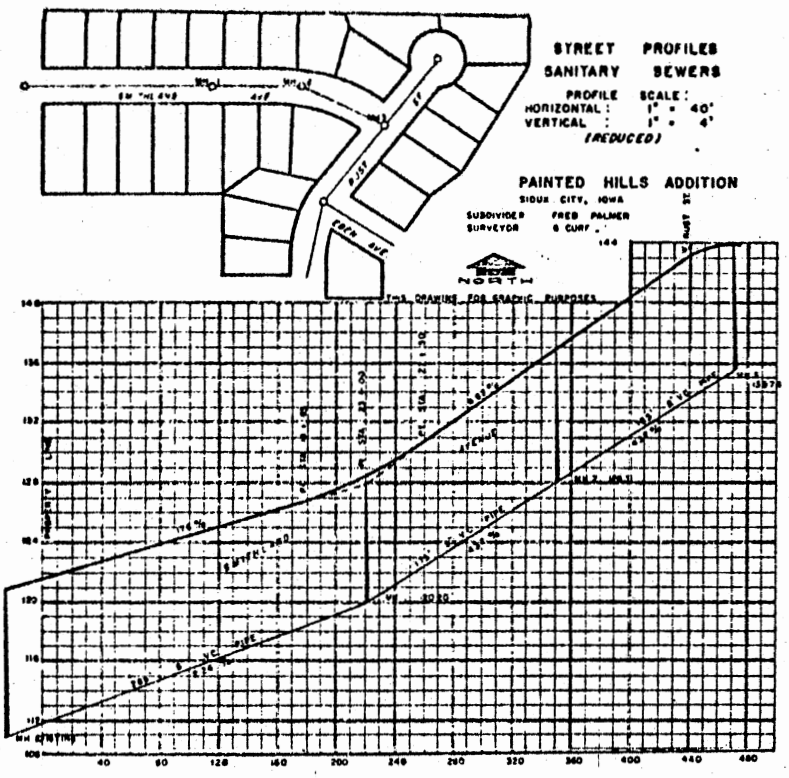


(c) Example of a Preliminary Sketch

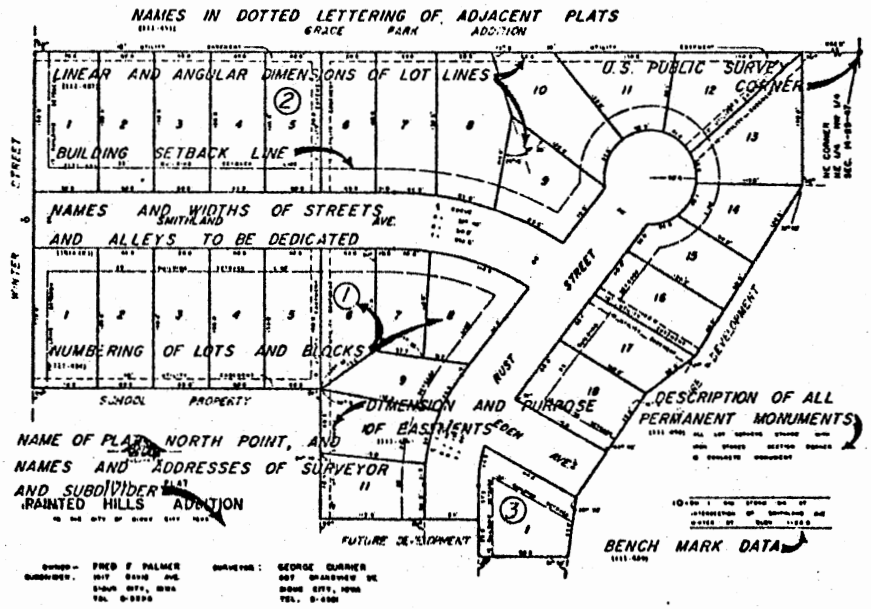


(d) Example of a Grading Plan

Figure 3. (Continued)



(e) Example of Street and Sewer Profiles



(f) Example of a Final Plat

Figure 3. (Continued)

viding and platting of lands. All horizontal distances must close, the areas of each lot and easement must be calculated, and all street and utility grades must be found.

One of the common problems of land surveying is the division of an irregularly shaped parcel of land into two or more parts with known areas (Moffitt and Bouchard 1975). Figure 4 graphically displays the problem. The total area of the figure ($AREA_{i-j-k-l}$) is to be found, then $AREA_{i-j-l}$ and $AREA_{j-k-l}$ are to be found. The solutions are detailed in Table I.

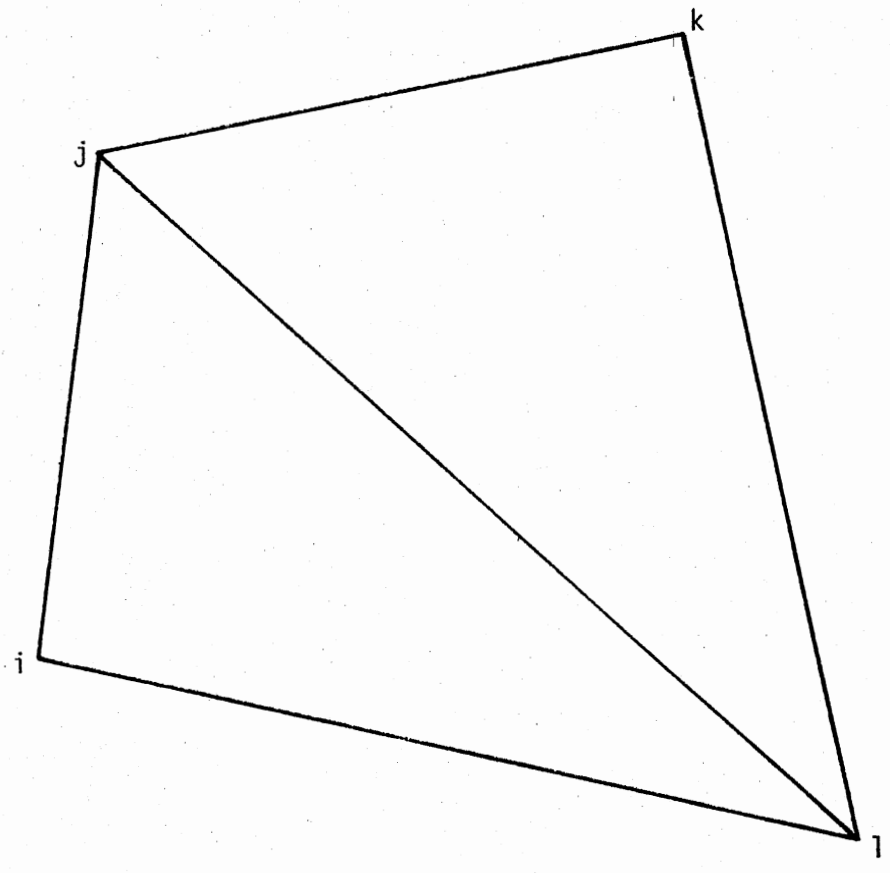


Figure 4. Illustration of Splitting Land Into Two Unequal Areas

TABLE I

SOLUTION FOR AREAS DESCRIBED IN FIGURE 4 BY DOUBLE MERIDIAN DISTANCE FORMULA

Side	Latitude	Departure	Double Meridian Distance	Double Area
$AREA_{i-j-k-l}$				
i-j	ΔN_{i-j}	ΔE_{i-j}	$\Delta E_{i-j} = DMD_{i-j}$	$\Delta N_{i-j} \times DMD_{i-j}$
j-k	ΔN_{j-k}	ΔE_{j-k}	$DMD_{i-j} + \Delta E_{i-j} + \Delta E_{j-k} = DMD_{j-k}$	$\Delta N_{j-k} \times DMD_{j-k}$
k-l	ΔN_{k-l}	ΔE_{k-l}	$DMD_{j-k} + \Delta E_{j-k} + \Delta E_{k-l} = DMD_{k-l}$	$\Delta N_{k-l} \times DMD_{k-l}$
l-i	ΔN_{l-i}	ΔE_{l-i}	$DMD_{k-l} + \Delta E_{k-l} + \Delta E_{l-i} = DMD_{l-i}$	$\Delta N_{l-i} \times DMD_{l-i}$
				Σ Double Area $\div 2 = AREA_{i-j-k-l}$
$AREA_{i-j-l}$				
i-j	ΔN_{i-j}	ΔE_{i-j}	$\Delta E_{i-j} = DMD_{i-j}$	$\Delta N_{i-j} \times DMD_{i-j}$
j-l	ΔN_{j-l}	ΔE_{j-l}	$DMD_{i-j} + \Delta E_{i-j} + \Delta E_{j-l} = DMD_{j-l}$	$\Delta N_{j-l} \times DMD_{j-l}$
l-i	ΔN_{l-i}	ΔE_{l-i}	$DMD_{j-l} + \Delta E_{j-l} + \Delta E_{l-i} = DMD_{l-i}$	$\Delta N_{l-i} \times DMD_{l-i}$
				Σ Double Area $\div 2 = AREA_{l-j-i}$
$AREA_{g-k-l}$				
j-k	ΔN_{j-k}	ΔE_{j-k}	$\Delta E_{j-k} + DMD_{j-k}$	$\Delta N_{j-k} \times DMD_{j-k}$
k-l	ΔN_{k-l}	ΔE_{k-l}	$DMD_{j-k} + \Delta E_{j-k} + \Delta E_{k-l} = DMD_{k-l}$	$\Delta N_{k-l} \times DMD_{k-l}$
l-j	ΔN_{l-j}	ΔE_{l-j}	$DMD_{k-l} + \Delta E_{k-l} + \Delta E_{l-j} = DMD_{l-j}$	$\Delta N_{l-j} \times DMD_{l-j}$
				Σ Double Area $\div 2 = AREA_{j-k-l}$

Source: Francis H. Moffitt and Harry Bouchard, "Computations for Parting Off Land," Surveying (1975).

Cartography and Computer Mapping

Cartography, the art of map making has been practiced as long as men have desired a permanent record of their environs. The oldest known map existing today is a small clay tablet depicting a man's estate in Mesopotamia dating from about 2800 B.C. (Raisz, 1962).

The information on a planar map may be represented in several forms. Conic, azimuthal, sinusoidal, and cylindrical maps are used to project landforms on world maps, (Merriman, 1947) while contour maps, isometric, volumetric and block diagrams are used to display various data for smaller areas (Raisz, 1962). Isometric and block diagrams have particular use in terrain analysis and geology.

Several computer programs exist which perform certain mapping functions. The most common of these are I.C.E.S. COGO and ROADS, and SYMAP (Montgomery, 1968). The I.C.E.S. (Integrated Civil Engineering System) program package contains several programs of interest to Civil Engineers, including structural, transportation, and construction scheduling programs.

The I.C.E.S. COGO (Coordinate Geometry) program uses problem oriented language (POL) commands which require the user to learn a completely new language before using the program. COGO may be applied to the solution of most surveying problems, as well as highway design, construction layout, and housing subdivision design. The line printer is used for all COGO output (Benz and Manke, 1970).

I.C.E.S. ROADS (Roadway Analysis and Design System) is a comprehensive and integrated engineering computer system for use in the solution of highway design problems. According to Suhrbier (1967), ROADS may also

be applied to railroad design, waterway channels, dams, and airport runways, as soon as a general location corridor has been defined. ROADS performs all horizontal and vertical calculations necessary in highway design. The line printer is the ROADS output device (see Figure 5).

SYMAP (Synagraphic Mapping System) was created by the Laboratory for Computer Graphics and Spatial Analysis at Harvard University. According to Dougenik and Sheehan (1975), SYMAP is designed to be used by geographers, planners, geologists, and others who have an interest in analyzing spatial data. Conformant, proximal, contour, trend surface, and residual maps can be made using SYMAP. The output device is the line printer.

Other computer programs exist which perform more specific mapping functions. SYMVU (Peucker, 1972) interfaces with SYMAP to perform three dimensional pen plots of data interpolated by SYMAP. Table II lists available mapping programs and their purposes.

TABLE II

COMPUTER MAPPING PROGRAMS FOR SPECIFIC PURPOSES

Program	Purpose
GEOFIT	Estimates sets of source coordinates from empirical geographical distributions.
POPMAP	Reads X,Y coordinates, with population, then draws population maps.
GRID	Interpolation to a square lattice from measures given at scattered X,Y locations.
RGRID	Produces a printer contour map from scattered observations.
CONTUR	Uses the 30-inch Calcomp Plotter to draw contour maps, stereograms, and perspective contours from data given in a matrix form.

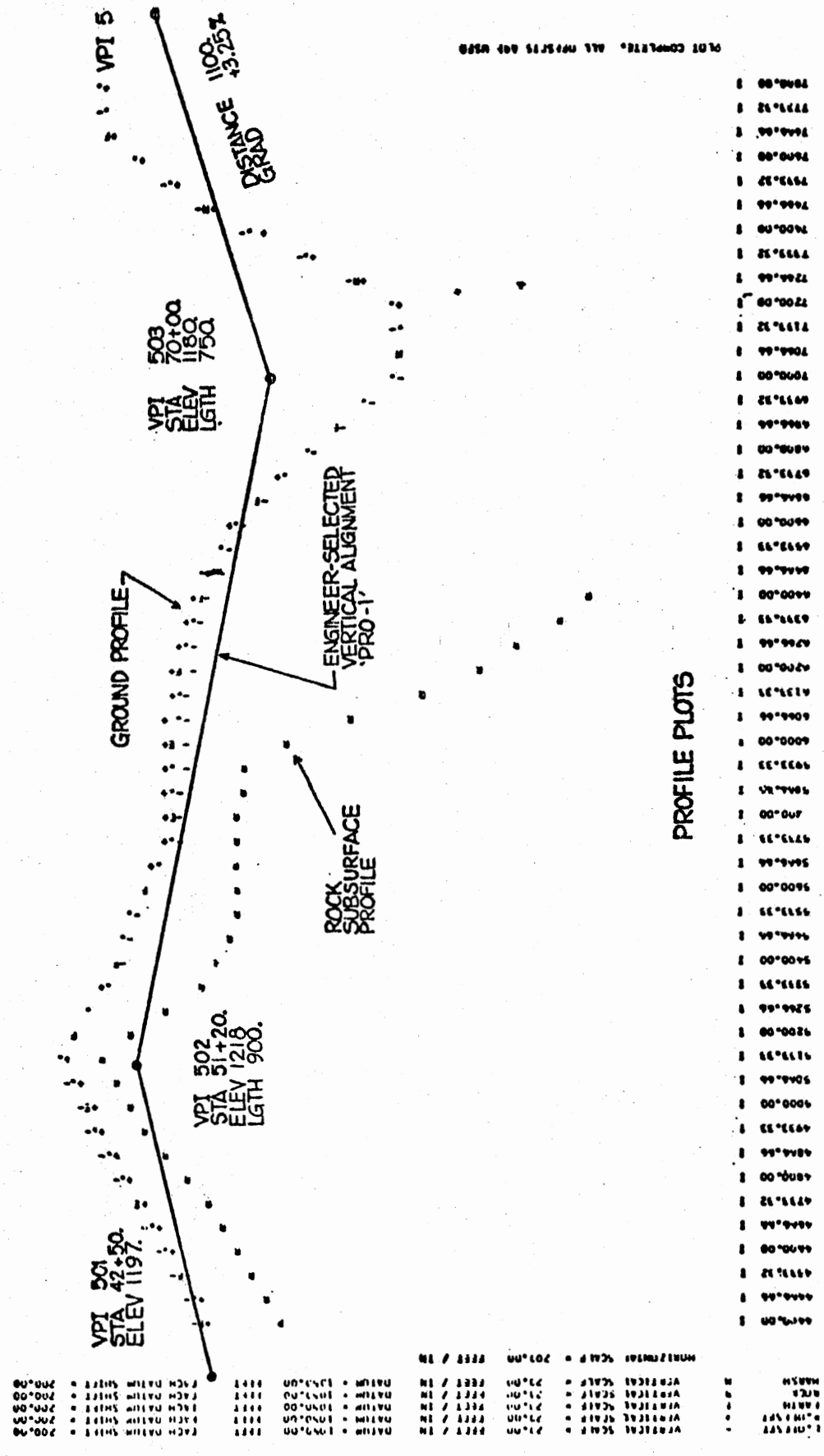


Figure 5. ICES ROADS Profile Output

CHAPTER III

THE NUMERICAL METHOD OF ANALYSIS

Horizontal Calculations

Method of Input

The basic method of input for the Subdivision program is a surveying system. In this system, the X (east) and Y (north) coordinates of a point are defined by naming a backsight point (i), naming a point "at" (j), naming a point to be defined (k), giving an angle ($\alpha_{direction}$) and a distance from the point "at" to the point being defined ($DIST_{j-k}$). Angles are separated by quadrants, being either angles to the right (α_{right}), angles to the left (α_{left}), deflections to the right ($\alpha_{defl\ right}$), or deflections to the left ($\alpha_{defl\ left}$). The quadrants of each type of angle are illustrated below.

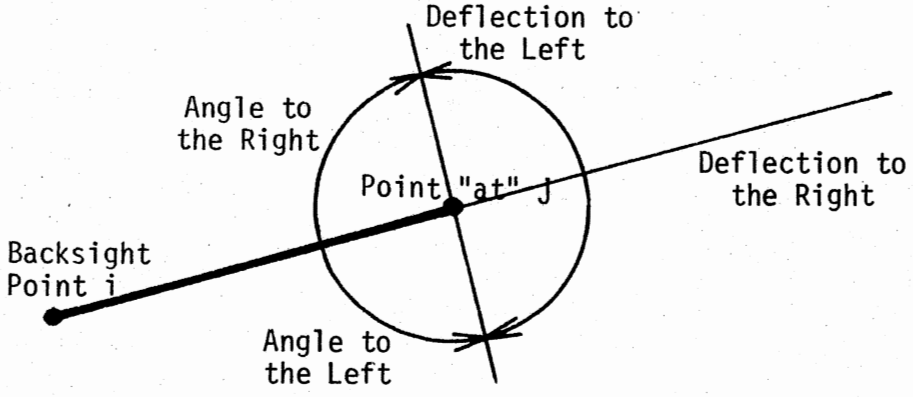


Figure 6. The Quadrants of Each Type of Surveying Angle

The method of defining the X (east) and Y (north) coordinates of the new point (k) is done according to the orientation of points i and j, and whether an angle to the right, angle to the left, deflection to the right, or deflection to the left is specified. The numerical method is given below.

If $S_{i,1}$ is greater than or equal to $S_{j,1}$, and $S_{i,2}$ is greater than or equal to $S_{j,2}$, and an angle to the right is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{right})) \quad (1)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{right})). \quad (2)$$

If an angle to the left is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{left})) \quad (3)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{left})). \quad (4)$$

If a deflection to the right is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{defl\ right})) \quad (5)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{defl\ right})). \quad (6)$$

If a deflection to the left is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{defl\ left})) \quad (7)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{defl\ left})). \quad (8)$$

If $S_{i,1}$ is less than $S_{j,1}$, and $S_{i,2}$ is greater than or equal to $S_{j,2}$, and an angle to the right is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{right})) \quad (9)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{right})). \quad (10)$$

If an angle to the left is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{left})) \quad (11)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{left})). \quad (12)$$

If a deflection to the right is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{defl\ right})) \quad (13)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{defl\ right})). \quad (14)$$

If a deflection to the left is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{defl\ left})) \quad (15)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{defl\ left})). \quad (16)$$

If $S_{i,1}$ is greater than or equal to $S_{j,1}$, and $S_{i,2}$ is less than $S_{j,2}$, and an angle to the right is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{right})) \quad (17)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{right})). \quad (18)$$

If an angle to the left is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{left})) \quad (19)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{left})). \quad (20)$$

If a deflection to the right is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{defl\ right})) \quad (21)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{defl\ right})). \quad (22)$$

If a deflection to the left is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{defl\ left})) \quad (23)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{\text{defl left}})). \quad (24)$$

If $S_{i,1}$ is less than $S_{j,1}$, and $S_{i,2}$ is less than $S_{j,2}$, and an angle to the right is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{\text{right}})) \quad (25)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{\text{right}})). \quad (26)$$

If an angle to the left is specified,

$$S_{k,1} = S_{j,1} - (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{\text{left}})) \quad (27)$$

$$S_{k,2} = S_{j,2} - (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{\text{left}})). \quad (28)$$

If a deflection to the right is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} + \alpha_{\text{defl right}})) \quad (29)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} + \alpha_{\text{defl right}})). \quad (30)$$

If a deflection to the left is specified,

$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j} - \alpha_{\text{defl left}})) \quad (31)$$

$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j} - \alpha_{\text{defl left}})). \quad (32)$$

If points i, j, and k lie on one line, no angle is specified. If point j lies between point i and point k, $DIST_{j-k}$ is positive. If point k lies between point i and point j, $DIST_{j-k}$ is negative. The analogy given above is then used.

Other methods which define new points or change the coordinates of stored points, such as intersecting two lines or adjusting a traverse are discussed below.

Retrieving and Plotting Stored Information

Upon completion of storing the points and their coordinates, information concerning the points such as the X (east) and Y (north) location, the distance between two points, or the area defined by a set of points may be desired. It may also be desirable for the computer to make a map of the horizontal area described, showing the points stored and important lines between them. The following sections of this chapter contain program segments which illustrate actual plotting procedures. The subroutines shown are COMPLOT plotting subroutines. An explanation for each follows the program segment.

Points and the Coordinates

To obtain a list of certain stored points and the coordinates as well as plot and label the point on the map, the following method is used. For a point i, the printer output contains the label i, $S_{i,2}$ (the north coordinate of point i) and $S_{i,1}$ (the east coordinate of point i). To plot and label point i, Equation sequence (33) is used.

```
XPEN = S(i,1) ÷ SCF
YPEN = S(i,2) ÷ SCF
SUBROUTINE SYMBOL
XPEN = XPEN + .07
YPEN = YPEN + .07
SUBROUTINE NUMBER                                    (33)
```

SUBROUTINE SYMBOL plots a special symbol centered on the plotting coordinates XPEN and YPEN. SUBROUTINE NUMBER places the label i on the plot

.07 inches above and to the right of the special symbol. i may also be placed to the left of the special symbol.

Lines, Distances, and Bearings

The distance between points i and j ($DIST_{i-j}$) is found by

$$DIST_{i-j} = ((\Delta N_{i-j})^2 + (\Delta E_{i-j})^2)^{.5}. \quad (34)$$

The bearing of the line is found by

$$\alpha_{i-j} = \text{arctangent } (\Delta N_{i-j} \div \Delta E_{i-j}). \quad (35)$$

If $S_{i,2}$ is less than $S_{j,2}$, the bearing is a north bearing. If $S_{i,2}$ is greater than $S_{j,2}$, the bearing is a south bearing. If $S_{i,1}$ is less than $S_{j,1}$, the bearing is an east bearing. If $S_{i,1}$ is greater than $S_{j,1}$, the bearing is a west bearing.

The line from point i to point j is drawn and labeled by Equation sequence (36).

$$XPEN = S_{i,1} \div SCF$$

$$YPEN = S_{i,2} \div SCF$$

SUBROUTINE PLOT

$$XPEN = S_{j,1} \div SCF$$

$$YPEN = S_{j,2} \div SCF$$

SUBROUTINE PLOT

$$XPEN = (((S_{i,1} + S_{j,1}) \div 2) \div SCF) - (\text{cosine } (90 - \alpha_{i-j}) \times .5) - .04$$

$$YPEN = (((S_{i,2} + S_{j,2}) \div 2) \div SCF) - (\text{sine } (90 - \alpha_{i-j}) \times .5) + .04$$

SUBROUTINE NUMBER

$$XPEN = (((S_{i,1} + S_{j,1}) \div 2) \div SCF) - (\text{cosine } (90 - \alpha_{i-j}) \times .6) + .1$$

$$YPEN = (((S_{i,2} + S_{j,2}) \div 2) \div SCF) - (\text{sine } (90 - \alpha_{i-j}) \times .6) - .1$$

SUBROUTINE SYMBOL. (36)

The first call to SUBROUTINE PLOT moves the pen to point i without drawing a line. The second call to SUBROUTINE PLOT moves the pen to point j, drawing the line. SUBROUTINE NUMBER labels the line with the length of the line, and SUBROUTINE SYMBOL labels the line with the bearing. If the length of the line is less than 1.7 x SCF, the distance and bearing of the line is placed in a table above and to the left of the entire plot.

Closing a Traverse

To close a traverse consisting of points i, j, . . ., l, and m, where the error of closure is assumed to be between point m and point i, the following equations are used:

$$C_{m,1} = \Delta E_{m-i} \times (n \div n) \quad (37)$$

$$C_{m,2} = \Delta N_{m-i} \times (n \div n) \quad (38)$$

$$C_{l,1} = \Delta E_{m-i} \times ((n - 1) \div n) \quad (39)$$

$$C_{l,2} = \Delta N_{m-i} \times ((n - 1) \div n) \quad (40)$$

.
.
.

$$C_{j,1} = \Delta E_{m-i} \times ((n - (n - 1)) \div n) \quad (41)$$

$$C_{j,2} = \Delta N_{m-i} \times ((n - (n - 1)) \div n) \quad (42)$$

$$C_{i,1} = 0 \quad (43)$$

$$C_{i,2} = 0. \quad (44)$$

Any point or set of points may be held from adjustment.

Horizontal Curves

Data for a curve defined by points i, j, and k, being the PC, center of curvature, and PT, respectively, are found below. The radius, arc, long chord, and tangent of a circular curve are illustrated in Figure 7.

$$ARC_{i-j-k} = 2 \times \pi \times RAD_{i-j-k} \times (\alpha_{i-j-k} \div 360) \quad (45)$$

$$CH_{i-j-k} = ((\Delta N_{i-k})^2 + (\Delta E_{i-k})^2)^{.5} \quad (46)$$

$$RAD_{i-j-k} = ((\Delta N_{i-j})^2 + (\Delta E_{i-j})^2)^{.5} \quad (47)$$

$$TAN_{i-j-k} = \text{tangent } (\alpha_{i-j-k} \div 2) \times RAD_{i-j-k} \quad (48)$$

$$\alpha_{i-j-k} = ((90 - ((180 - \alpha_{i-j-k}) \div 2)) \div ARC_{i-j-k}) \times 60 \quad (49)$$

The interior angle α_{i-j-k} is defined completely in the Lots and Traverses section.

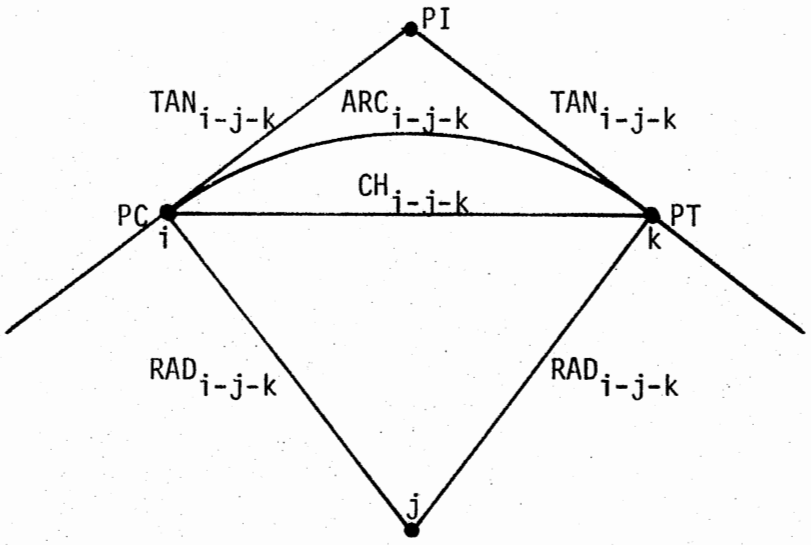


Figure 7. Parts of a Horizontal Circular Curve

Horizontal curves are plotted by connecting chords subtending two degrees of central angle. With point i remaining as the PC and being called the backsight point, point j being the center of curvature and the point "at," and point 1 being the temporary point to which the chords are to be drawn, curves are plotted as shown in Equation sequence (50).

SUBROUTINE PLOT

$$\alpha_{i\text{-}j\text{-}1} = 2$$

$$S_{1,1} = S_{j,1} + (RAD_{i\text{-}j\text{-}k} \times \text{sine } (\alpha_{i\text{-}j} + \alpha_{i\text{-}j\text{-}1}))$$

$$S_{1,2} = S_{j,2} + (RAD_{i\text{-}j\text{-}k} \times \text{cosine } (\alpha_{i\text{-}j} + \alpha_{i\text{-}j\text{-}1}))$$

$$XPEN = S_{1,1} \div SCF$$

$$YPEN = S_{1,2} \div SCF$$

SUBROUTINE PLOT

$$\alpha_{i\text{-}j\text{-}1} = \alpha_{i\text{-}j\text{-}1} + 2 \qquad (50)$$

The first call to SUBROUTINE PLOT moves the pen to the PC (point i) of the curve. The second call to SUBROUTINE PLOT draws the chord. After angle $\alpha_{i\text{-}j\text{-}1}$ is incremented by two degrees, program control transfers back, new coordinates are calculated for point 1, and another chord is drawn.

Lots and Traverses

For a traverse consisting of points i, j, . . ., 1, and m, it may be necessary to calculate the area and interior angles between the points defining the traverse. There are sixteen ways for two lines to intersect in a four quadrant system. If the first line is defined by points i and j, and the second line is defined by points j and k (thus the intersection

of the two lines occurs at point j), the 16 ways for the two lines to intersect may be shown graphically, as in Figure 8. Table III contains the interior angle calculation for each case shown in Figure 8.

The area of traverse i, j, . . ., l, and m is found by the double meridian distance method as in Equation (51).

$$AREA_{i-\ldots-m} = (\Delta N_{i-j} \times DMD_{i-j} + \Delta N_{j-k} \times DMD_{j-k} + \ldots$$
$$\Delta N_{l-m} \times DMD_{l-m} + \Delta N_{m-i} \times DMD_{m-i}) \div 2. \qquad (51)$$

The DMD's are defined as being twice the sum of all ΔE's occurring before the line being calculated plus the ΔE of the line being calculated.

Horizontal Intersections

Horizontal intersections are made iteratively. To intersect a line segment defined by points i and j with a line defined by points l and m, the line segment defined by points i and j is extended, with the coordinates of a new point k being defined with each iteration (see Figure 9(a)). The iterations are ended when α_{l-m-k} is equal to zero (see Equation sequence (52)).

$$DIST_{j-k} = .0001$$
$$S_{k,1} = S_{j,1} + (DIST_{j-k} \times \text{sine } (\alpha_{i-j}))$$
$$S_{k,2} = S_{j,2} + (DIST_{j-k} \times \text{cosine } (\alpha_{i-j}))$$
$$\text{IF } (\alpha_{l-m-k} = 0.0), \text{ transfer out}$$
$$DIST_{j-k} = DIST_{j-k} + .0001. \qquad (52)$$

After $DIST_{j-k}$ is incremented, control transfers back and the coordinates for a new point k are determined.

To intersect a line segment defined by points i and j with a curve having a center at point l and a known radius, the line segment is

TABLE III

METHOD FOR THE CALCULATION OF THE INTERIOR ANGLE FOR EACH OF THE SIXTEEN POSSIBLE INTERSECTION CASES

Case No.	Interior Angle α_{i-j-k}
1	$\alpha_{j-k} - \alpha_{i-j}$
2	$\pi - \alpha_{i-j} - \alpha_{j-k}$
3	$\pi + \alpha_{i-j} - \alpha_{j-k}$
4	$\alpha_{i-j} + \alpha_{j-k}$
5	$\pi - \alpha_{i-j} - \alpha_{j-k}$
6	$\alpha_{i-j} - \alpha_{j-k}$
7	$\alpha_{i-j} + \alpha_{j-k}$
8	$\pi + \alpha_{i-j} - \alpha_{j-k}$
9	$\pi - \alpha_{i-j} + \alpha_{j-k}$
10	$\alpha_{i-j} + \alpha_{j-k}$
11	$\alpha_{i-j} - \alpha_{j-k}$
12	$\pi - \alpha_{i-j} - \alpha_{j-k}$
13	$\alpha_{i-j} + \alpha_{j-k}$
14	$\pi + \alpha_{i-j} - \alpha_{j-k}$
15	$\pi - \alpha_{i-j} - \alpha_{j-k}$
16	$\alpha_{j-k} - \alpha_{i-j}$

If the interior angle is less than zero, the interior angle is changed to the absolute value of the interior angle. If the interior angle is greater than π, the interior angle is changed to $\pi - (\alpha_{i-j-k} - \pi)$.

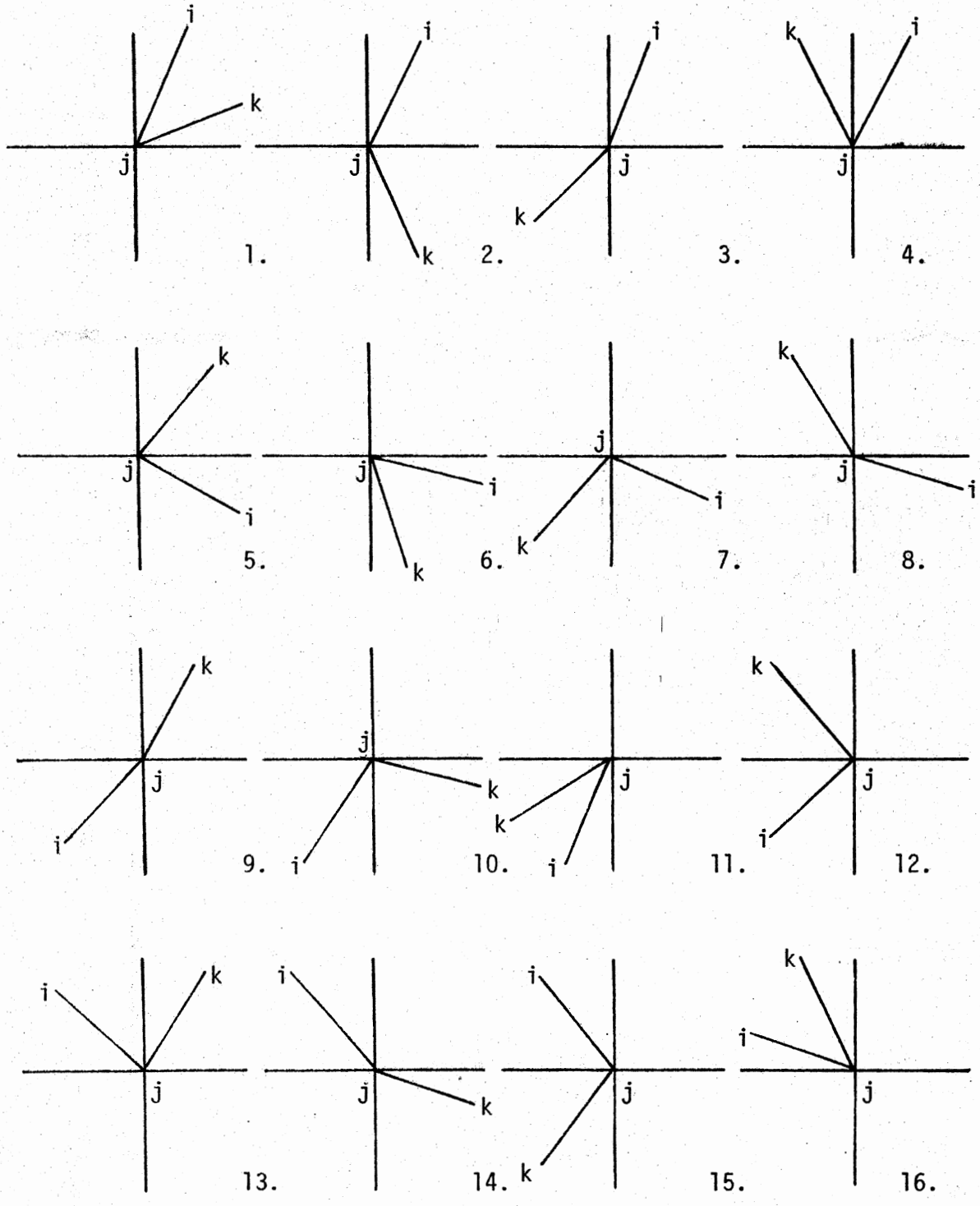
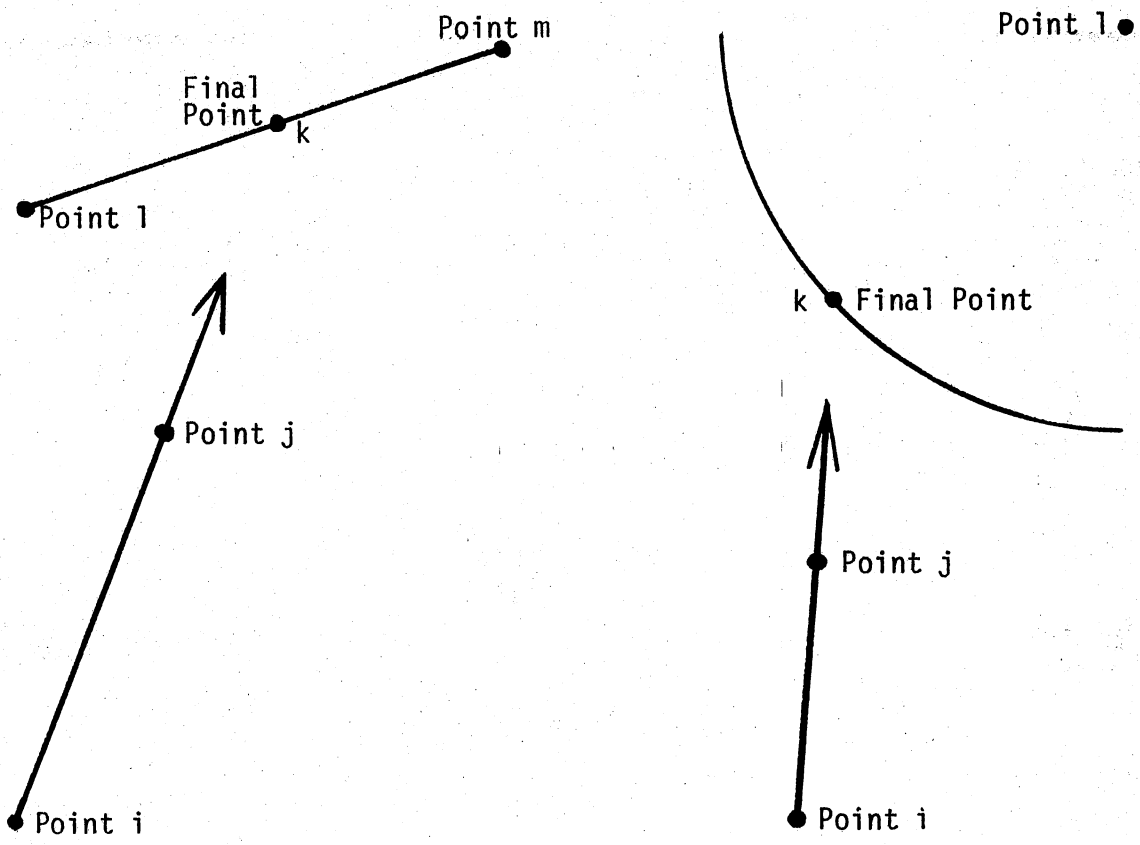


Figure 8. The Sixteen Possible Ways for Two Lines to Intersect in a Four-Quadrant System



(a) Intersecting Two Lines

(b) Intersecting a Line With a Curve

Figure 9. Horizontal Intersections

extended iteratively as in Equation set (52) with the coordinates of a new point k being defined with each iteration. The iterations end when k is one radius away from point 1 (see Figure 9(b)).

If for some reason an intersection is not made after a certain number of iterations, or if the coordinates of point k ($S_{k,1}$ and $S_{k,2}$) extend beyond certain allowable limits (depending on the magnitude of SCF), the program will abort and an error message describing the error is written.

Vertical Calculations

Defining the Vertical Grid

The principal feature of the vertical portion of the program is the program's ability to take random input information and arrange the information into a grid. An elevation is assigned to each grid point by weighting the five nearest random input points. Also, a qualitative fact, such as soil type, vegetation, or depth to bedrock, is assigned to each grid point on a proximal basis (depending on that piece of information given for the nearest random input point).

The method for defining the vertical grid is a three-dimensional interpolation using the inverse of the sums of the square of the distance of a particular point from the five nearest random input points. The nearest point is designated at point number one, the farthest is designated as point number five. The grid may be as large as 54 grid points in the north (Y) direction, by 72 grid points in the east (X) direction, with the distance between the grids in both directions being SCF ÷ 3. The method is detailed in Figure 10 and in Equations (53) and (54). For grid location XG, YG,

POINT	ELEVATION	$DIST^2_{(YG,XG)-i}$	$\frac{\Sigma DIST^2_{(YG,XG)-i}}{DIST^2_{(YG,XG)-i}}$
1	105.00	4	22.500
2	113.25	9	10.000
3	110.50	16	5.625
4	120.75	25	3.600
5	125.00	36	2.500
		Σ 90	Σ 44.225

$\frac{\Sigma DIST^2_{(YG,XG)-i} \div DIST^2_{(YG,XG)-i}}{\Sigma(\Sigma DIST^2_{(YG,XG)-i} \div DIST^2_{(YG,XG)-i})}$	WEIGHTED ELEVATION
.5088	53.424
.2261	25.606
.1272	14.056
.0814	9.829
.0565	7.063
Σ 1.0000	Σ 109.978

Figure 10. Numerical Example of Finding the Elevation at a Grid Point From Random Input Points (Elevations and Distances are Assumed)

$$A_{YG,XG,1} = \sum_{i=1}^{5} (B_{i,3} \times (((\Sigma(DIST_{(YG,XG)-i})^2 + (DIST_{(YG,XG)-i})^2) \div (\Sigma(\Sigma(DIST_{(YG,XG)-i})^2 \div (DIST_{(YG,XG)-1})^2))))) \quad (53)$$

$$A_{YG,XG,2} = B_{1,4}. \quad (54)$$

Three-Dimensional Pictures

Three-dimensional pictures are drawn according to the method given in Equations (55) and (56). A rotation angle (β), direction (east or west), an altitude angle (γ), and a vertical exaggeration factor (EX) are given. The rotation is about the origin, therefore the plotting coordinates at XG, YG are

$$XPEN = ((\text{cosine } (\alpha_{i-o} + \beta)) \times DIST_{(YG,XG)-0}) \div (SCF \times SH) \quad (55)$$

$$YPEN = ((((\text{sine } (\alpha_{i-o} + \beta)) \times DIST_{(YG,XG)-0}) \times (\text{sine } \gamma)) + ((A_{YG,XG,1} - EL_{min}) \times EX)) \div (SCF \times SH). \quad (56)$$

The plot is drawn by incrementing XG while holding YG constant to draw the east-west lines, then incrementing YG while holding XG constant to draw the north-south lines. The data or elevation at the grid points are labeled after the east-west line segment is drawn. The shrink factor (SH) is determined by testing the corners of the area to be plotted to see if they will fit on the plot. If YPEN in the corner test is outside of acceptable limits (depending on the scale of the plot), the shrink factor SH is multiplied by 1.1 until YPEN for the corner fits within the limits. Increasing SH has the effect of shrinking the entire picture.

Upon the completion of plotting the vertical control grid three-dimensionally, the boundary is then plotted with the black pen. The intermediate point's elevations are found similarly to $A_{YG,XG,1}$, and are plotted according to Equations (55) and (56).

Contour Map

The qualitative fact or elevation of each grid point on the vertical control grid is plotted before any other plotting takes place on the contour map. The lower left corner of the symbol is the location of the grid point. The contour interval is given and the contours between EL_{min} and EL_{max} are found. For any four-sided element, if the first contour lies between $A_{YG,XG,1}$ and $A_{YG,XG+1,1}$, the contour elevation between these points is located by interpolation and the pen is moved to that location. If this contour lies between $A_{YG,XG,1}$ and $A_{YG+1,XG,1}$, the contour location between these two points is located and a line is drawn to that position. Sides $A_{YG+1,XG,1}$ to $A_{YG+1,XG+1,1}$, and $A_{YG+1,XG+1,1}$ to $A_{YG,XG+1,1}$ are checked similarly (see Figures 11 and 12).

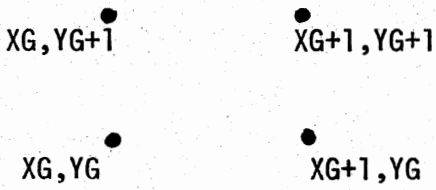


Figure 11. Labeling Scheme for a Four-Sided Element on the Vertical Control Grid

CONTOUR PASSING BETWEEN	PEN INTERPOLATION
$A_{YG,XG,1} - A_{YG,XG+1,1}$	$XPEN = ((XG \times (SCF \div 3)) + ((EL_{contour} - A_{YG,XG,1}) \div (A_{YG,XG+1,1} - A_{YG,XG,1})) \times (SCF \div 3)) \div SCF$ $YPEN = (YG \times (SCF \div 3)) \div SCF$
$A_{YG,XG,1} - A_{YG+1,XG,1}$	$XPEN = (XG \times (SCF \div 3)) \div SCF$ $YPEN = (YG \times (SCF \div 3)) + ((EL_{contour} - A_{YG,XG,1}) \div (A_{YG+1,XG,1} - A_{YG,XG,1})) \times (SCF \div 3)) \div SCF$
$A_{YG+1,XG,1} - A_{YG+1,XG+1,1}$	$XPEN = ((XG \times (SCF \div 3)) + ((EL_{contour} - A_{YG+1,XG,1}) \div (A_{YG+1,XG+1,1} - A_{YG+1,XG,1})) \times (SCF \div 3)) \div SCF$ $YPEN = (YG + 1 \times (SCF \div 3)) \div SCF$
$A_{YG+1,XG+1,1} - A_{YG,XG+1,1}$	$XPEN = (XG + 1 \times (SCF \div 3)) \div SCF$ $YPEN = (YG \times (SCF \div 3)) + ((EL_{contour} - A_{YG,XG+1,1}) \div (A_{YG+1,XG+1,1} - A_{YG,XG+1,1})) \times (SCF \div 3)) \div SCF$

Figure 12. Pen Interpolation for Contour Plotting

Upon completion of all contour lines, the boundary is drawn and labeled. A special feature allows lines to be drawn between previously stored points, and labeled on the contour map. This may be done in any color (see Lines, Distances, and Bearings, page 21).

Printer Plots

Accurate printer plots may be printed showing the information stored in the vertical control grid. YG is held at 54 while XG increments from 1 to 20. $A_{YG,XG,1}$ is printed at each grid point. YG is then decremented by one and the same process occurs, until YG reaches 1. YG is then returned to 54 and XG is incremented from 21 to 40. In this manner, a representation of the vertical control grid is given in strips 20 locations wide. A proximal map is printed in the same manner when $A_{YG,XG,2}$ is printed. Any information which may be represented on a proximal map may be shown in this manner. When printed on an eight-lines-per-inch printer, there is a 30 percent east-west exaggeration. When printed on a six-lines-per-inch printer, there is a 16 percent east-west exaggeration.

Profiles and Grades

Selected profiles may be plotted by listing an array of points between which plots of cross sections are desired, and a vertical scale at which the plot is to be made. The horizontal scale of the plot is one inch equals SCF. The array is then split into pairs of points for profile plotting. The profile for pairs of points is then plotted in 30 increments; the increments are defined in Equations (57) and (58).

$$\Sigma N = \Delta N_{i-j} \div 30 \qquad (57)$$

$$\Sigma E = \Delta E_{i-j} \div 30 \tag{58}$$

New north (Y) and east (X) coordinates are found for each increment along the line. The elevation at those coordinates is found similarly to $A_{YG,XG,1}$, and those elevations are plotted against horizontal increments of $DIST_{i-j} \div 30$.

Grades are laid out on the plot and digitized in SCF * 10 increments on the printer output. To define grades, the station and elevation of all vertical tangent intersections are given. If a vertical curve of a certain length subtends a certain vertical point of intersection, the curve length is given. The station of the beginning of a vertical curve is found by subtracting one-half of the length of the vertical curve from the station of the point of intersection of the vertical tangents. The grade of the vertical tangents is found in Equation (59).

$$r_{ij} = (rEL_{i-j} \div DIST_{i-j}) \times 100. \tag{59}$$

The elevation of the beginning of a vertical curve is found by multiplying one-half of the length of the curve by $-r_{i-j}$. The elevation at point j along a vertical curve beginning at point i and ending at point k is found in Equation (60).

$$\text{Elevation} = ((((r_2 - r_1) \div (DIST_{i-k} \div 100.)) \div 2.) \times (DIST_{i-j})^2) + (r_1 \times DIST_{i-j}) + \text{Elevation BVC.} \tag{60}$$

Curves are plotted and printed out in increments of SCF ÷ 10.

CHAPTER IV

RESULTS AND DISCUSSION

Modern standards for housing subdivision design require the designer to consider much more than horizontal layout of the subdivision. DeChiara and Koppelman (1978), in their discussion of subdivisions suggest a vicinity review, topographic analysis, a preliminary sketch, and graphic analysis before attempting to design the final plat. The subdivision program package has applications in all of these areas.

The results of this research and the running of numerous example problems indicates the following: (see Figures 13 to 26, and Appendices A to G).

The horizontal portion of the program has widely varied uses, from the closure of traverses to the actual platting of subdivisions. A meticulous method of adjusting triangulation grids (done by considering one three or four-sided element at a time) is also possible.

Figure 13 shows a plot of a small traverse which required horizontal adjustment. The printer output appears in Appendix A. The distances and bearings of the north, south, east, and west lines were given. The point nearest the center (point 700 on the printer output) was defined by the interesection of the two lines running through it. A forty foot easement line is shown running parallel to the north line. The intersection feature of the program was used to establish the point and easement line.

Figure 14 is the plotter output of a larger traverse which was to be

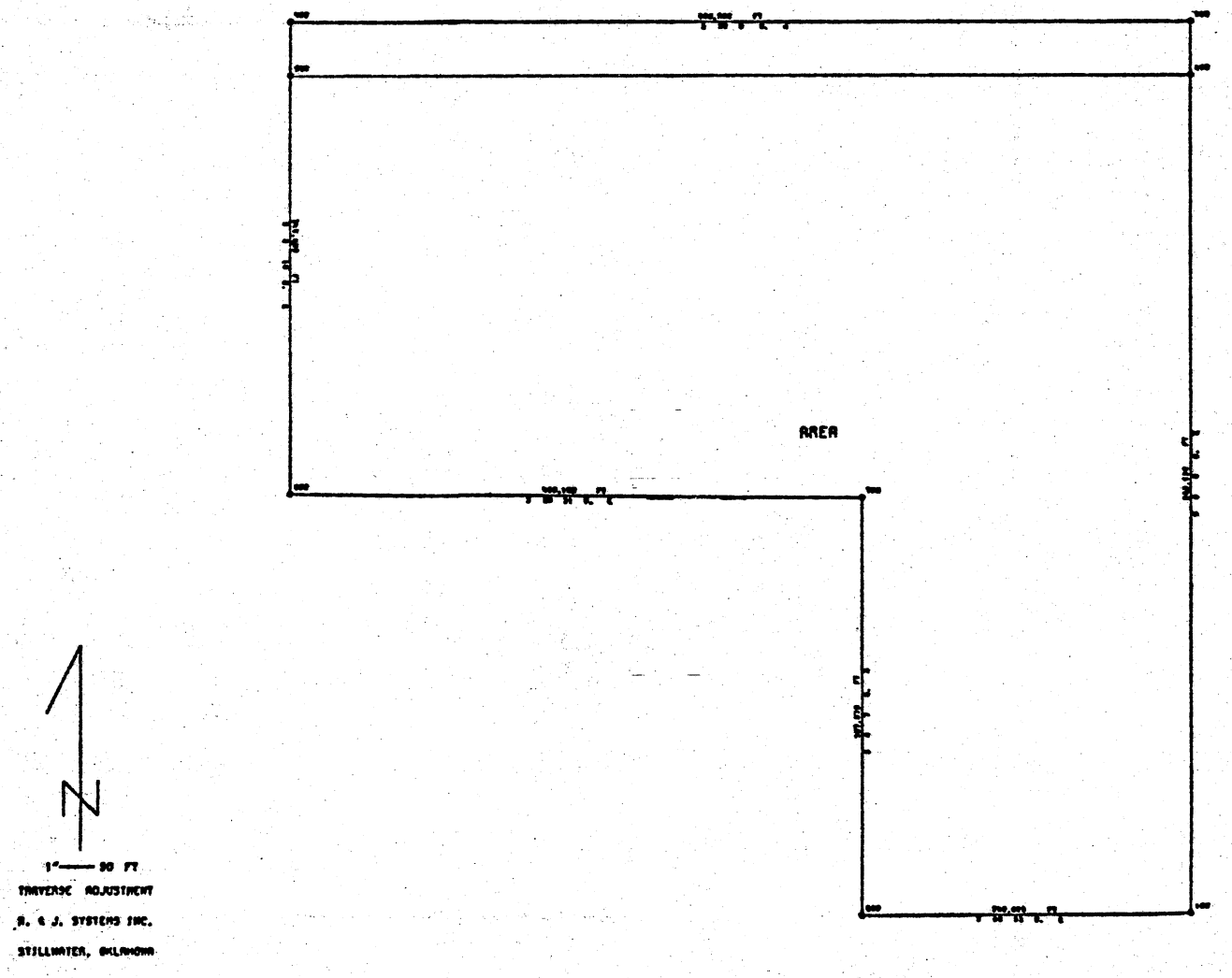


Figure 13. Horizontal Closure and Traverse Example

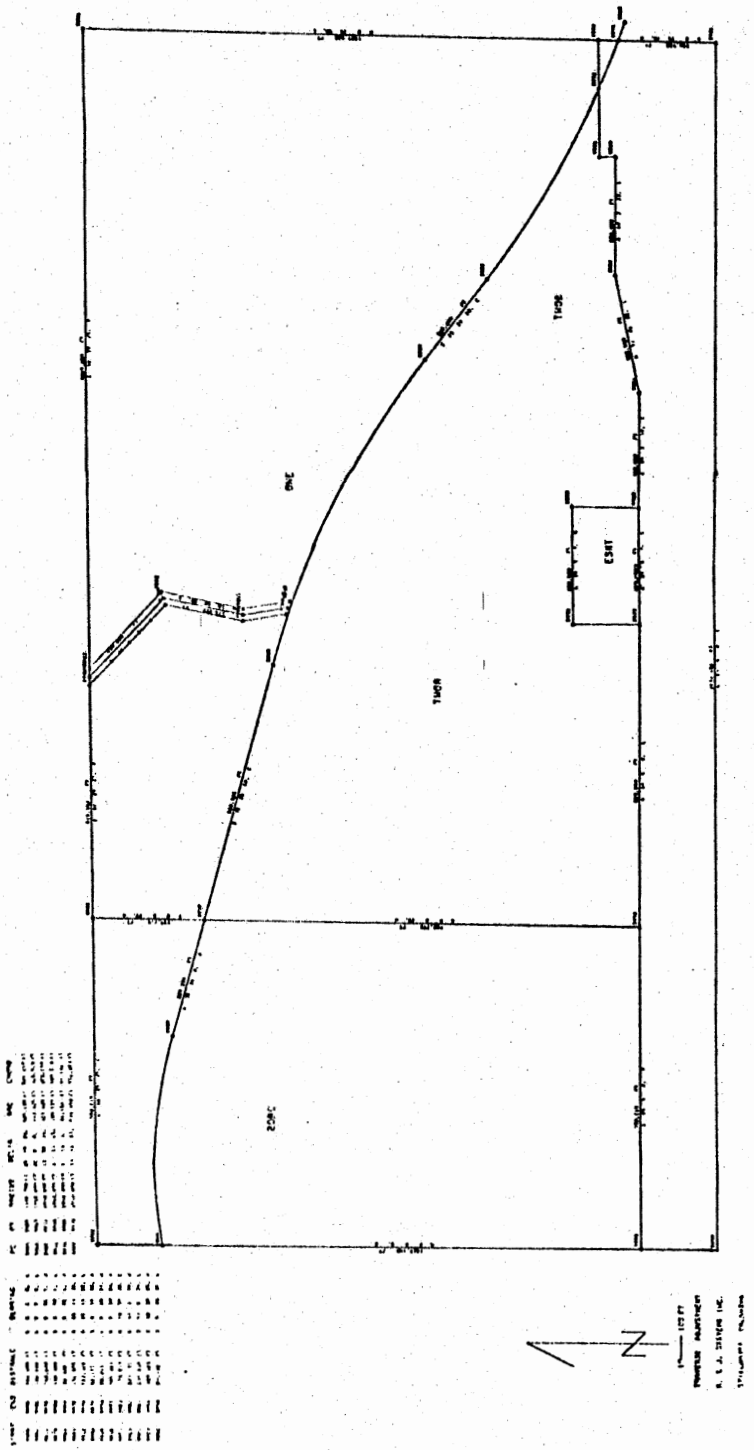


Figure 14. Lotting and Traverse Adjustment

divided into several large lots. The printer output for this problem appears in Appendix B. The area appearing along the south edge is the right-of-way for state highway 33. The curved line running from near the northwest corner of the traverse toward the southeast corner is the centerline of old state highway 33. Twenty acres was to be parted off of the west end (Lot Number 20AC in the printer output), and the areas of the remaining tracts north and south of the old state highway were to be found. An easement from the old state highway to the north edge of the traverse appears as the group of three parallel line segments in Figure 14.

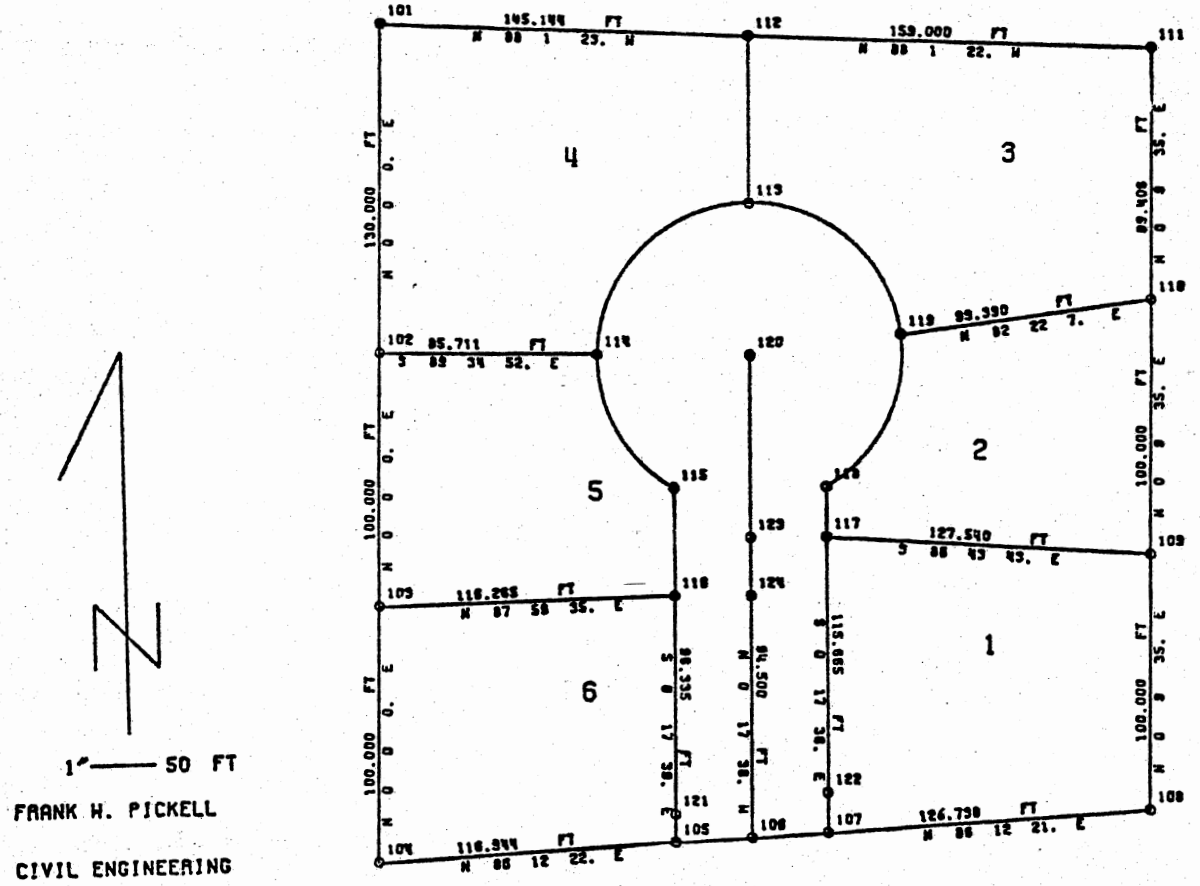
A small housing subdivision appears in Figure 15. This subdivision consists of six lots and a short cul-de-sac. A closure of the perimeter was necessary, and points 115, 118, 107, and 105 were intersected. Lines 102 to 114, 113 to 112, and 119 to 110 are radial about point 120. The printer output for this subdivision appears in Appendix C.

Figure 16 is a plot of a triangulation course (the Oklahoma State University surveying traverse). The printer output in Appendix D shows that an adjustment was made for each four-sided element in the traverse. As each three or four-sided area was input, it was adjusted, thus eliminating error as it was introduced. The various elements were then grouped according to selected triangles, and the distances, bearings and area information was found for them.

The results for the fifth traverse are shown in Figure 17 and tabulated in Appendix E. This traverse is a fifteen lot subdivision, with all streets, lots, easements, and setback lines shown. Five concentric arcs may be observed around the centers of curvature on "Sunny Hills Drive", being the building setback lines, property lines and street

PC	PT	TANGENT	RADIUS	DELTA	ARC	CHORD
115	114	35.191 FT	60.000 FT	60 42 47.	63.578 FT	60.645 FT
114	113	58.287 FT	60.000 FT	89 17 8.	95.500 FT	84.322 FT
113	119	52.770 FT	60.000 FT	82 39 49.	86.565 FT	78.250 FT
119	118	55.968 FT	60.000 FT	87 20 14.	78.515 FT	68.527 FT

START	END	DISTANCE	BEARING
116	115	42.743 FT	N 0 17 39. W
105	106	30.056 FT	N 86 12 20. E
124	123	23.000 FT	N 0 17 38. W
123	120	71.710 FT	N 0 17 38. W
119	117	19.748 FT	S 0 17 38. E
106	107	30.055 FT	N 86 12 23. E
115	112	88.060 FT	N 0 17 42. W



1" —— 50 FT

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Figure 15. Small Subdivision Test Problem

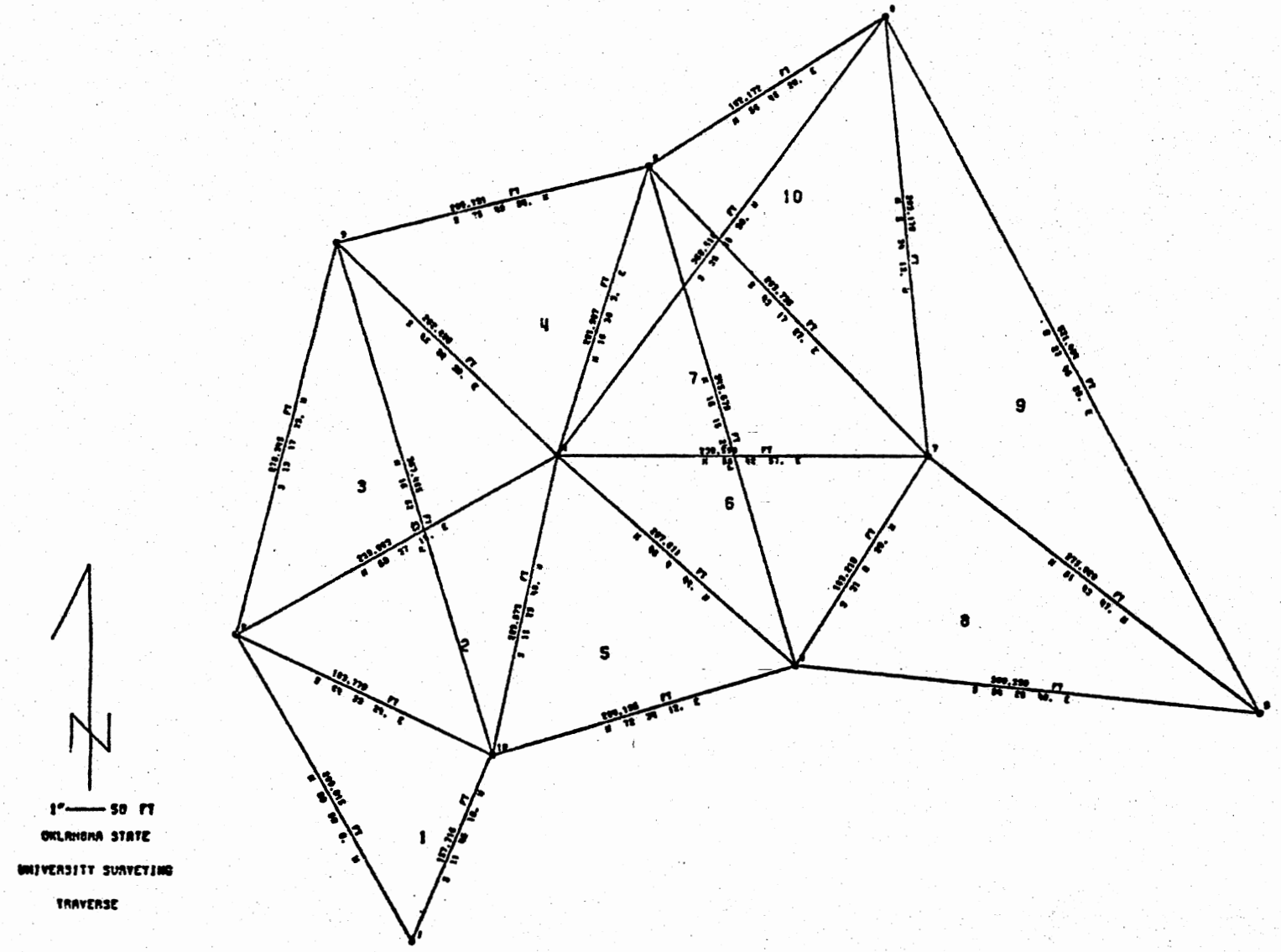


Figure 16. Triangulation Example, Oklahoma State University Surveying Traverse

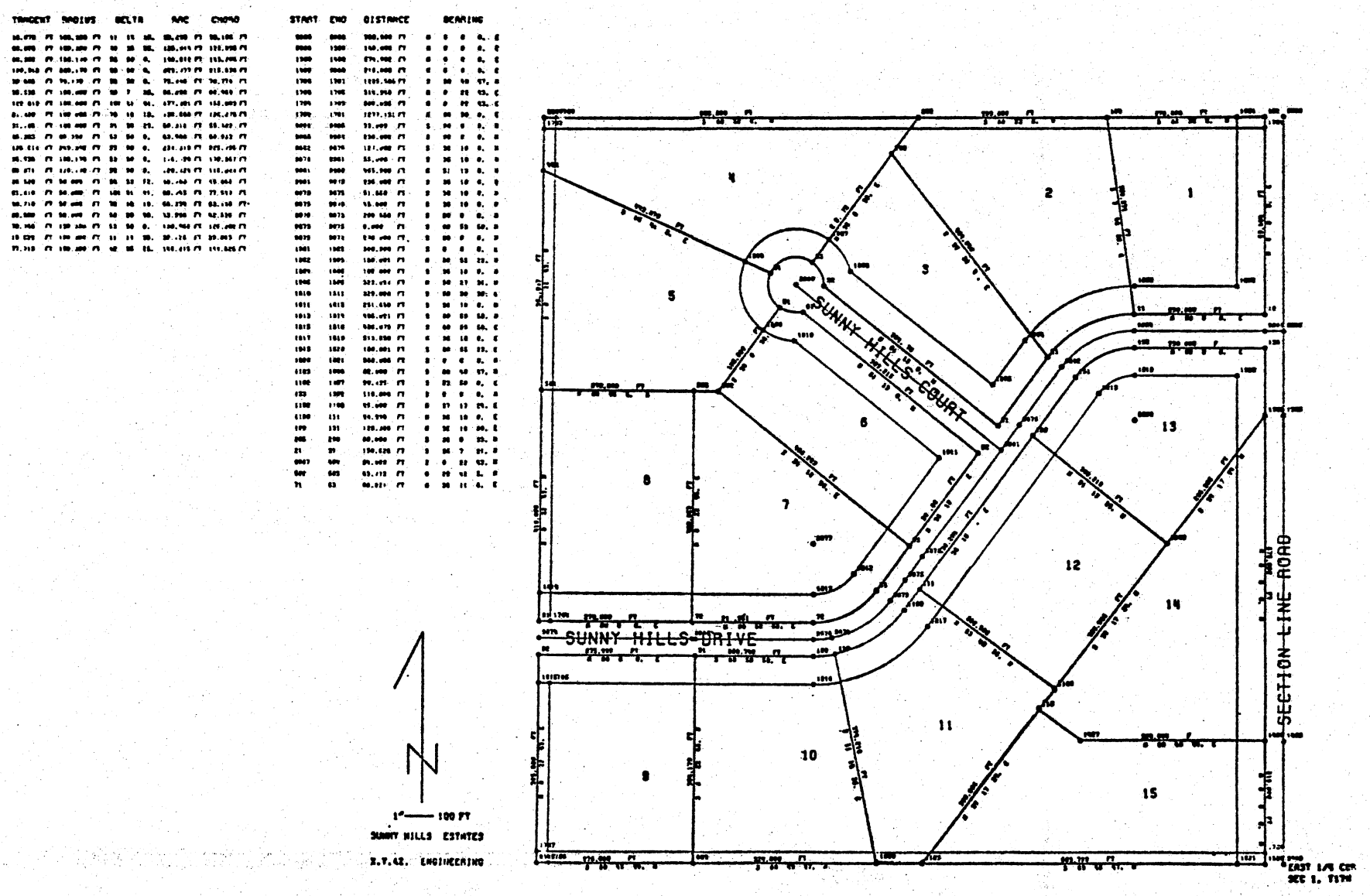


Figure 17. Complete Housing Subdivision Example

centerlines. In the original plot, the red pen was used for the twenty foot utility easements and street centerlines, the blue pen was used for the building set back lines, and the black pen was used for the lot lines, and lot labeling.

The sixth problem is a vertical control problem. An example of a traverse with topographical information was devised, and the contours were digitized for random input. Soil types using the Unified Soil Classification system were also input. It was assumed that a road would be layed out between points 100 and 200, a sanitary sewer location would be shown between points 100 and 300, and a water line would be shown between points 200 and 400. (See Figures 18 and 19). Printer output of the vertical elevation grid and the vertical data grid appear in Appendix F. Figure 20 and Figure 21 depict three-dimensional pictures of the area, from different perspectives. Figure 22 is a printer output of the vertical tangents and curve, and Figure 23 is a plotter profile of the street.

The final example is the use of the vertical portion of the program for use in an actual floodplain study. Figure 24 depicts the Caney River as it flows through Bartlesville, Oklahoma. The hatched lines indicate areas which have been developed. The wavy lines depict areas prone to flooding in a 100 year flood. The random elevations were taken at the section corners, quarter-section corners and section centers. The data for each individual grid point was given the label FL if the point was subject to flooding, DR if it remains dry in a 100 year flood. The point was given the label UR if it was in an urban or developed area and RL if it was rural. Thus, FLRL would indicate a flooded rural area, FLUR a flooded urban area, etcetera. The data grid and the elevation grid

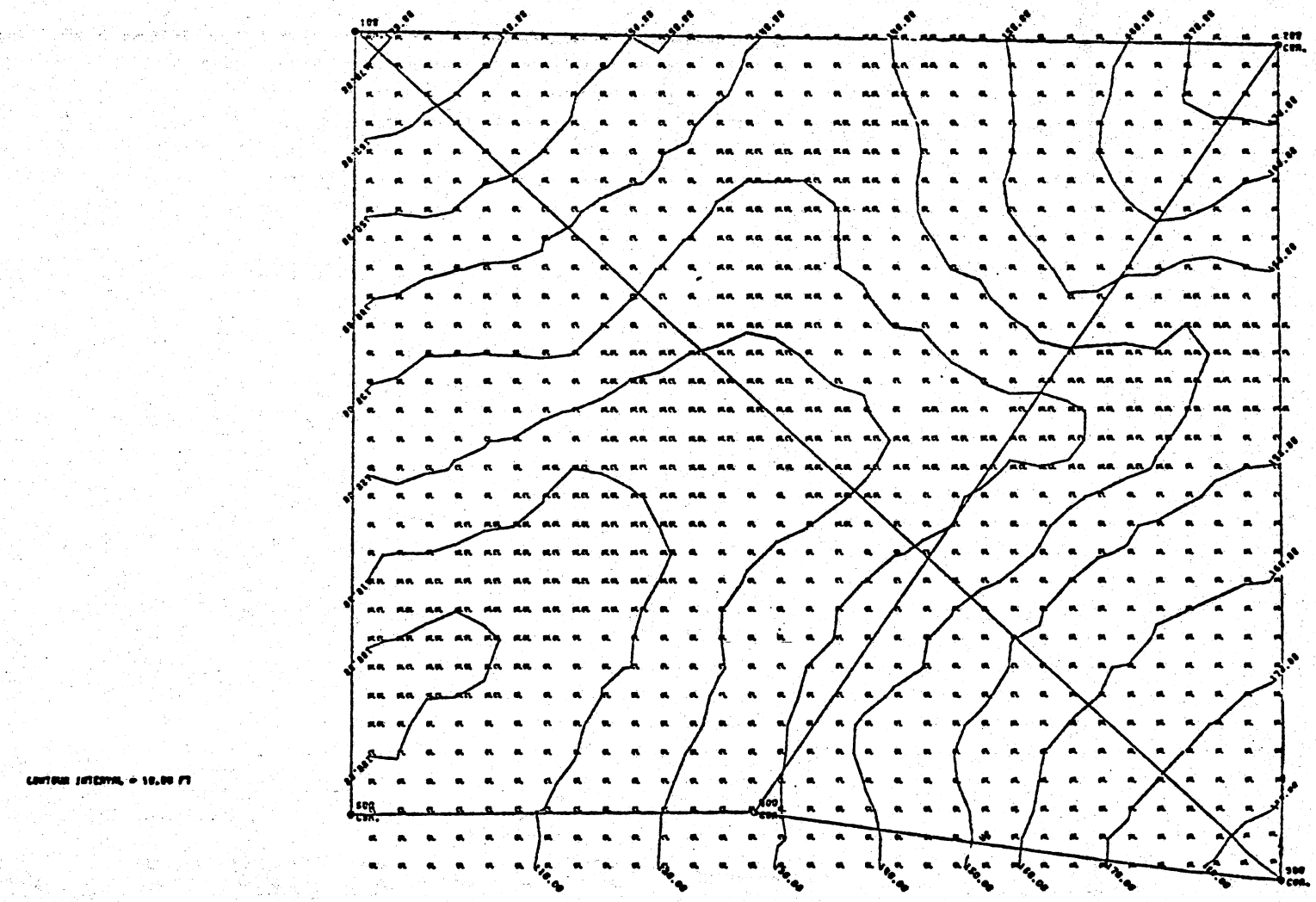


Figure 18. Topographic Map of Traverse, Ten Foot Contour Intervals

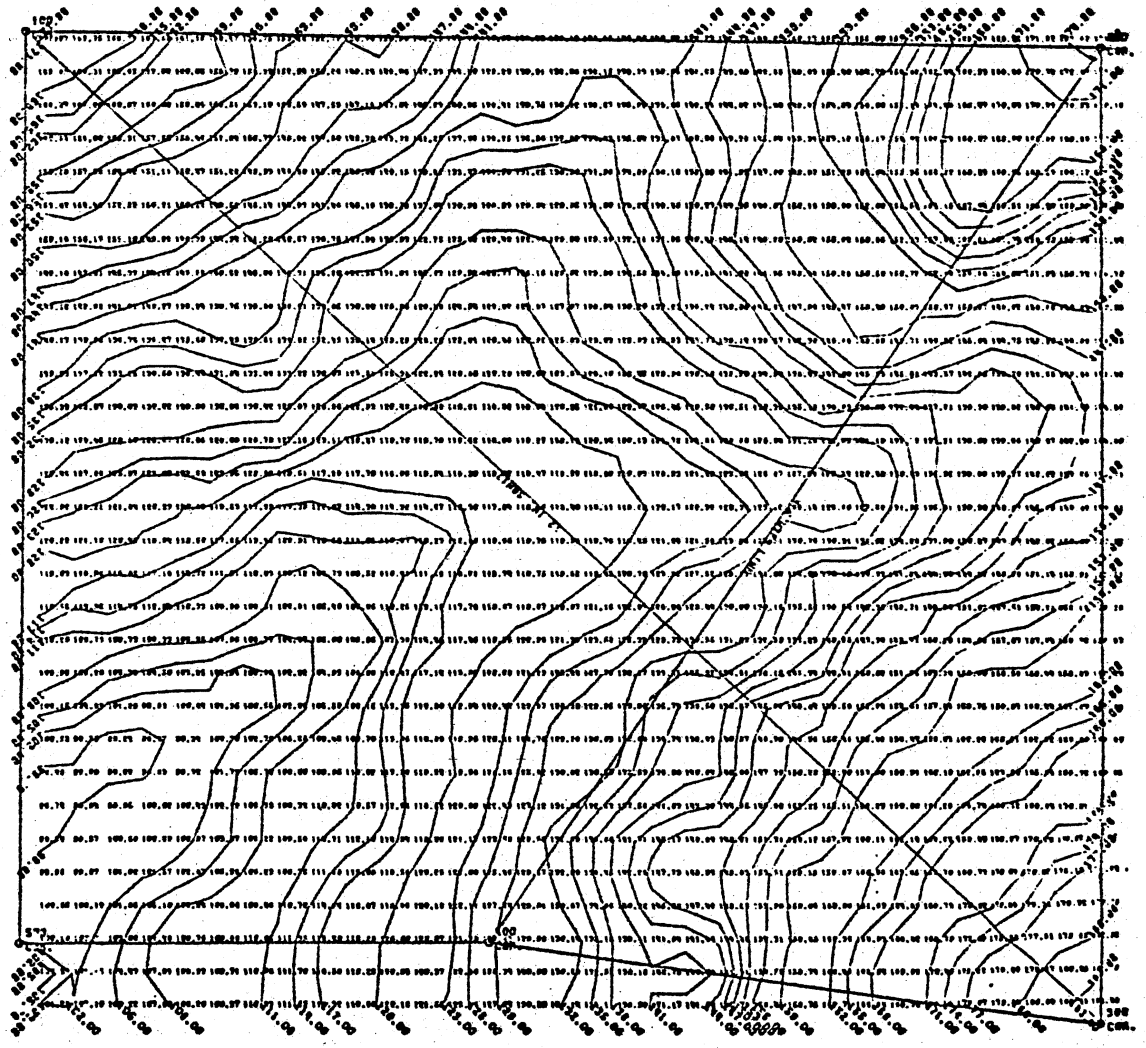


Figure 19. Topographic Map of Traverse, Three Foot Contour Intervals

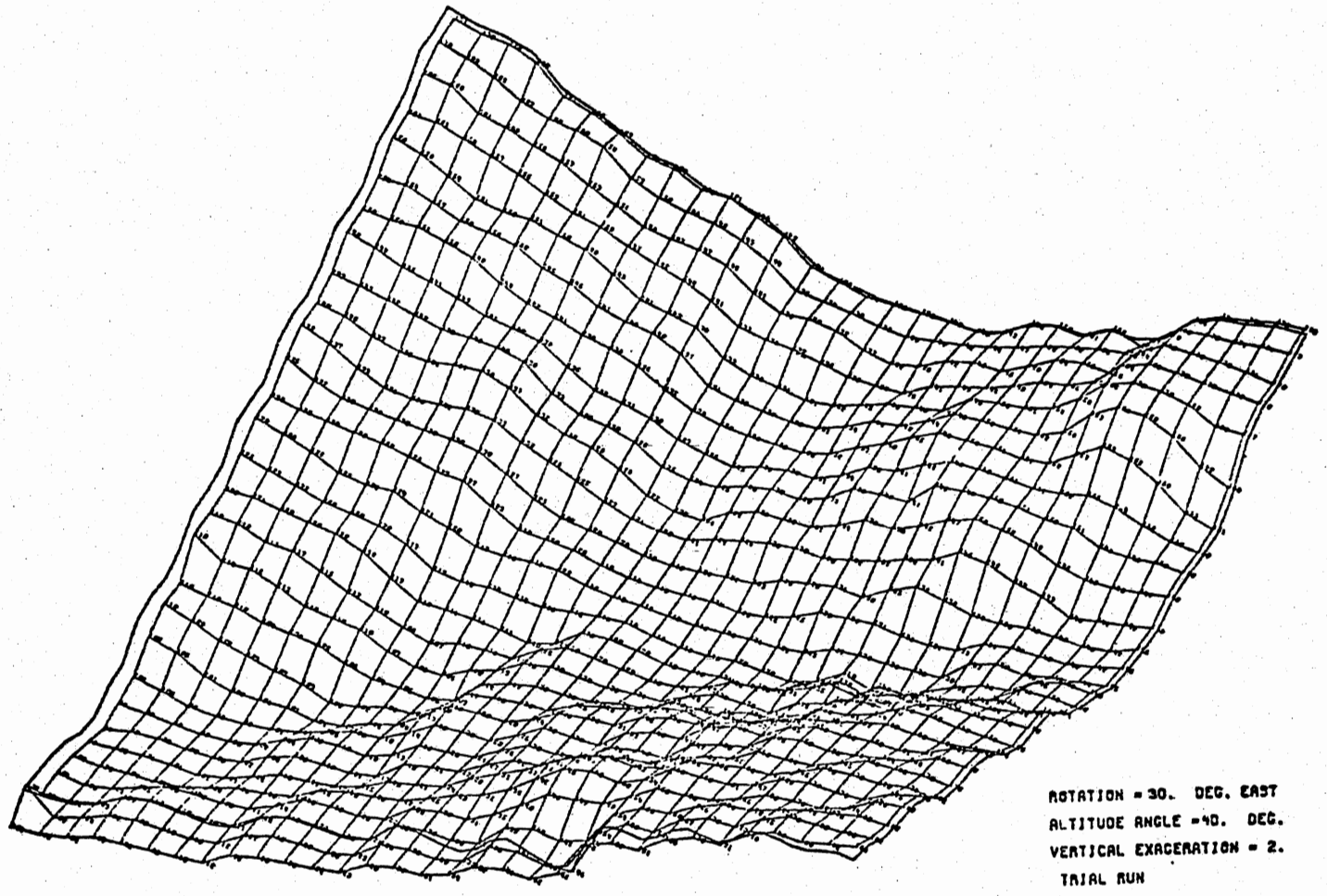


Figure 20. Three-Dimensional Plot, Elevations at Grid Points

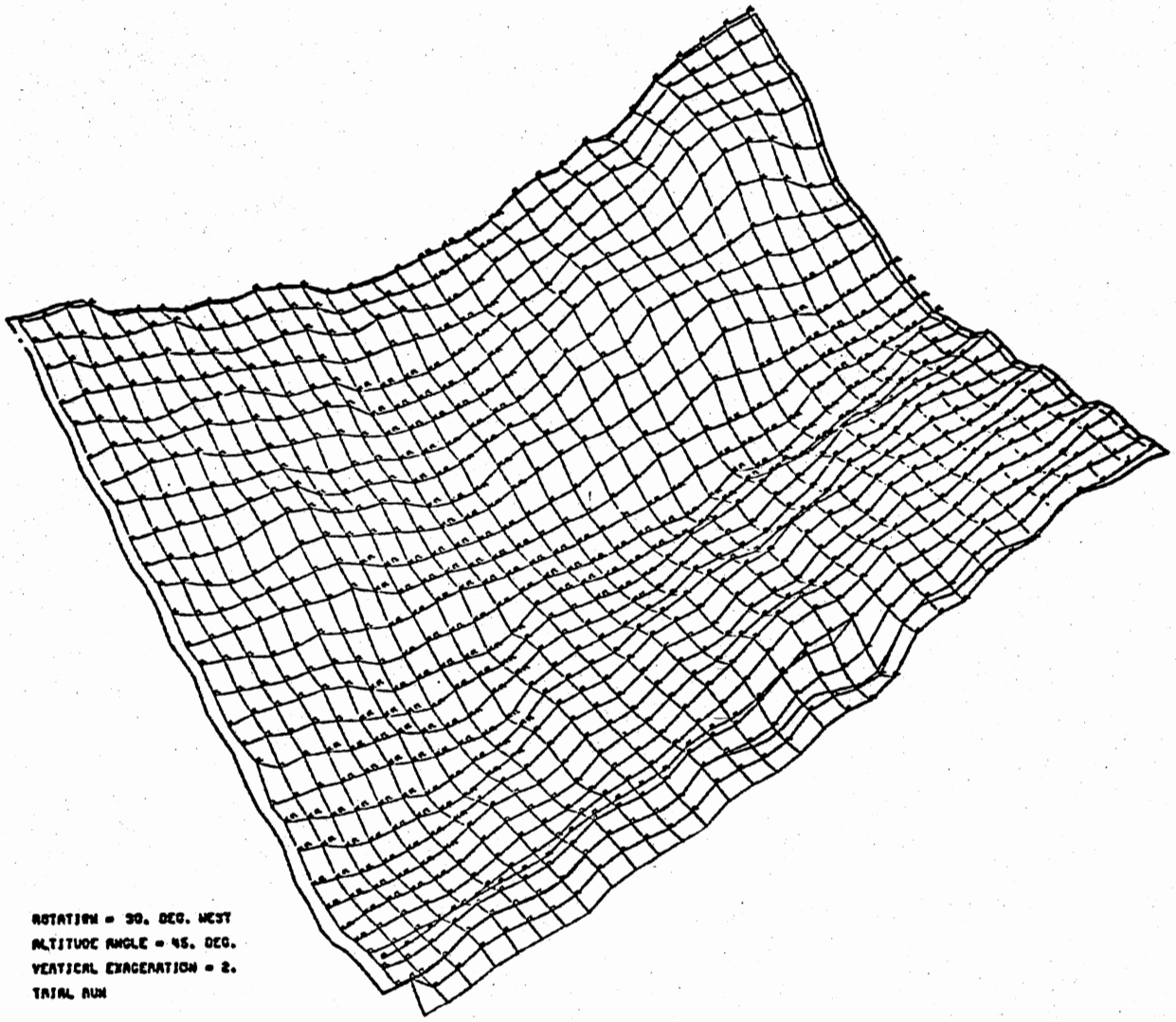
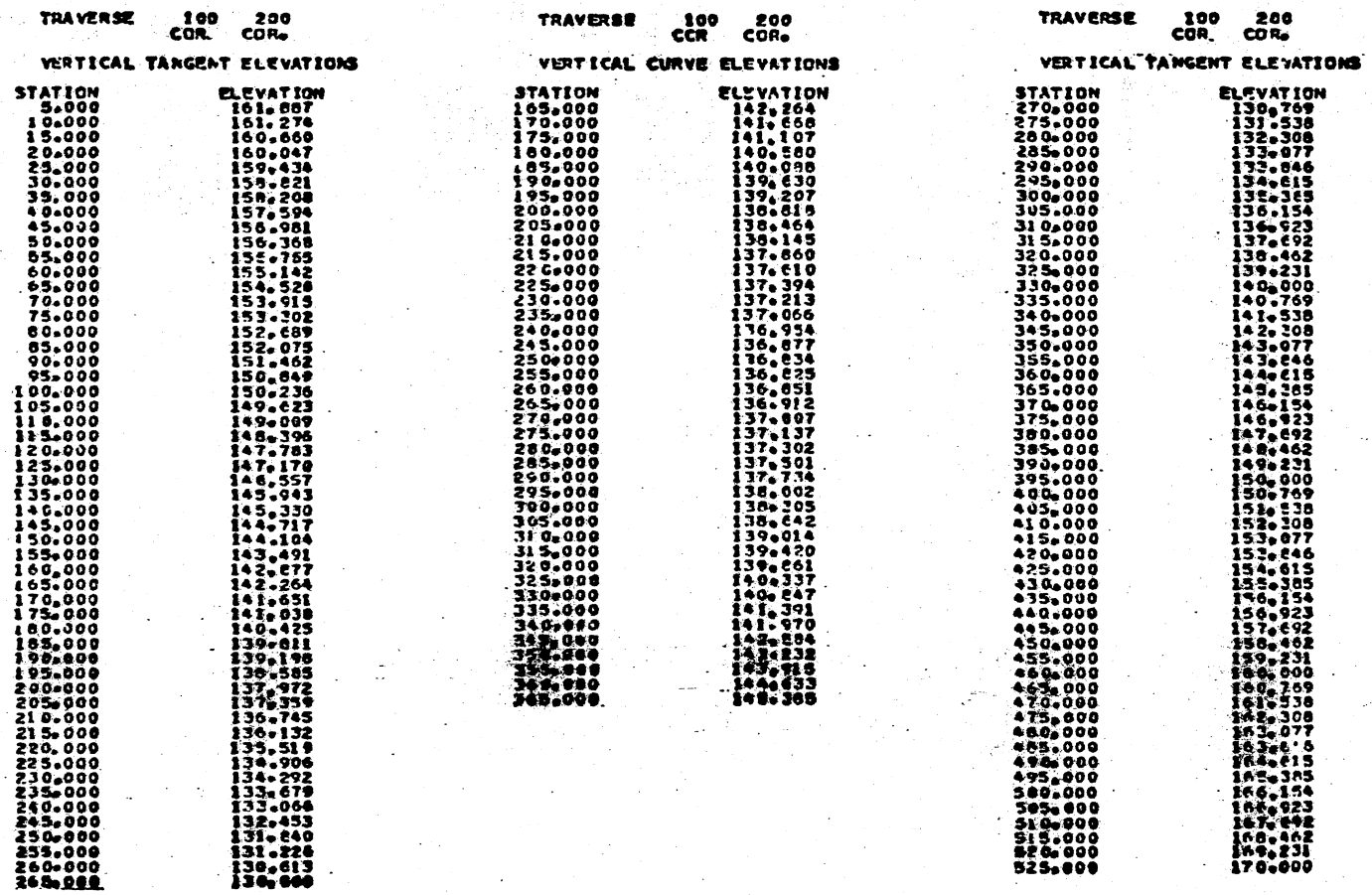


Figure 21. Three-Dimensional Plot, Soil Type at Grid Points



TRAVERSE 100 200
COR. COR.

VERTICAL TANGENT ELEVATIONS

STATION	ELEVATION
5.000	161.887
10.000	161.276
15.000	160.666
20.000	160.047
25.000	159.434
30.000	158.821
35.000	158.208
40.000	157.594
45.000	156.981
50.000	156.368
55.000	155.755
60.000	155.142
65.000	154.528
70.000	153.915
75.000	153.302
80.000	152.689
85.000	152.075
90.000	151.462
95.000	150.849
100.000	150.236
105.000	149.623
110.000	149.009
115.000	148.396
120.000	147.783
125.000	147.170
130.000	146.557
135.000	145.943
140.000	145.330
145.000	144.717
150.000	144.104
155.000	143.491
160.000	142.877
165.000	142.264
170.000	141.651
175.000	141.038
180.000	140.425
185.000	139.811
190.000	139.198
195.000	138.585
200.000	137.972
205.000	137.359
210.000	136.745
215.000	136.132
220.000	135.519
225.000	134.906
230.000	134.292
235.000	133.679
240.000	133.066
245.000	132.453
250.000	131.840
255.000	131.226
260.000	130.613
265.000	130.000

TRAVERSE 100 200
CCR COR.

VERTICAL CURVE ELEVATIONS

STATION	ELEVATION
165.000	142.264
170.000	141.668
175.000	141.107
180.000	140.580
185.000	140.088
190.000	139.630
195.000	139.207
200.000	138.818
205.000	138.464
210.000	138.145
215.000	137.860
220.000	137.610
225.000	137.394
230.000	137.213
235.000	137.066
240.000	136.954
245.000	136.877
250.000	136.834
255.000	136.825
260.000	136.851
265.000	136.912
270.000	137.007
275.000	137.137
280.000	137.302
285.000	137.501
290.000	137.734
295.000	138.002
300.000	138.305
305.000	138.642
310.000	139.014
315.000	139.420
320.000	139.861
325.000	140.337
330.000	140.847
335.000	141.391
340.000	141.970
345.000	142.584
350.000	143.232
355.000	143.915
360.000	144.633
365.000	145.385

TRAVERSE 100 200
COR. COR.

VERTICAL TANGENT ELEVATIONS

STATION	ELEVATION
370.000	130.769
375.000	131.538
380.000	132.308
385.000	133.077
390.000	133.846
395.000	134.615
400.000	135.385
405.000	136.154
410.000	136.923
415.000	137.692
420.000	138.462
425.000	139.231
430.000	140.000
435.000	140.769
440.000	141.538
445.000	142.308
450.000	143.077
455.000	143.846
460.000	144.615
465.000	145.385
470.000	146.154
475.000	146.923
480.000	147.692
485.000	148.462
490.000	149.231
495.000	150.000
500.000	150.769
505.000	151.538
510.000	152.308
515.000	153.077
520.000	153.846
525.000	154.615
530.000	155.385
535.000	156.154
540.000	156.923
545.000	157.692
550.000	158.462
555.000	159.231
560.000	160.000
565.000	160.769
570.000	161.538
575.000	162.308
580.000	163.077
585.000	163.846
590.000	164.615
595.000	165.385
600.000	166.154
605.000	166.923
610.000	167.692
615.000	168.462
620.000	169.231
625.000	170.000

Figure 22. Printer Output of Vertical Tangents, Curve

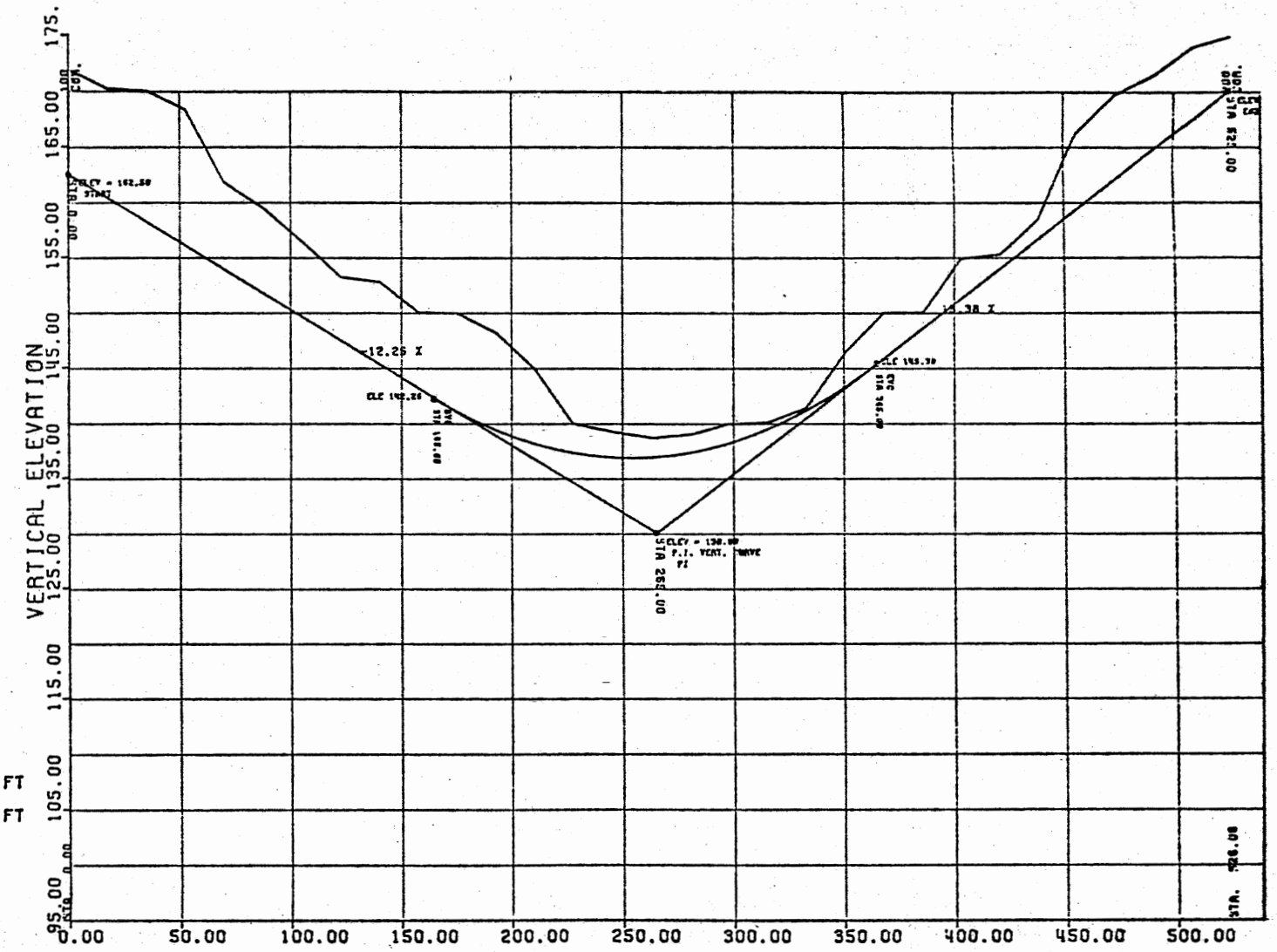


Figure 23. Plotter Output of Street Profile

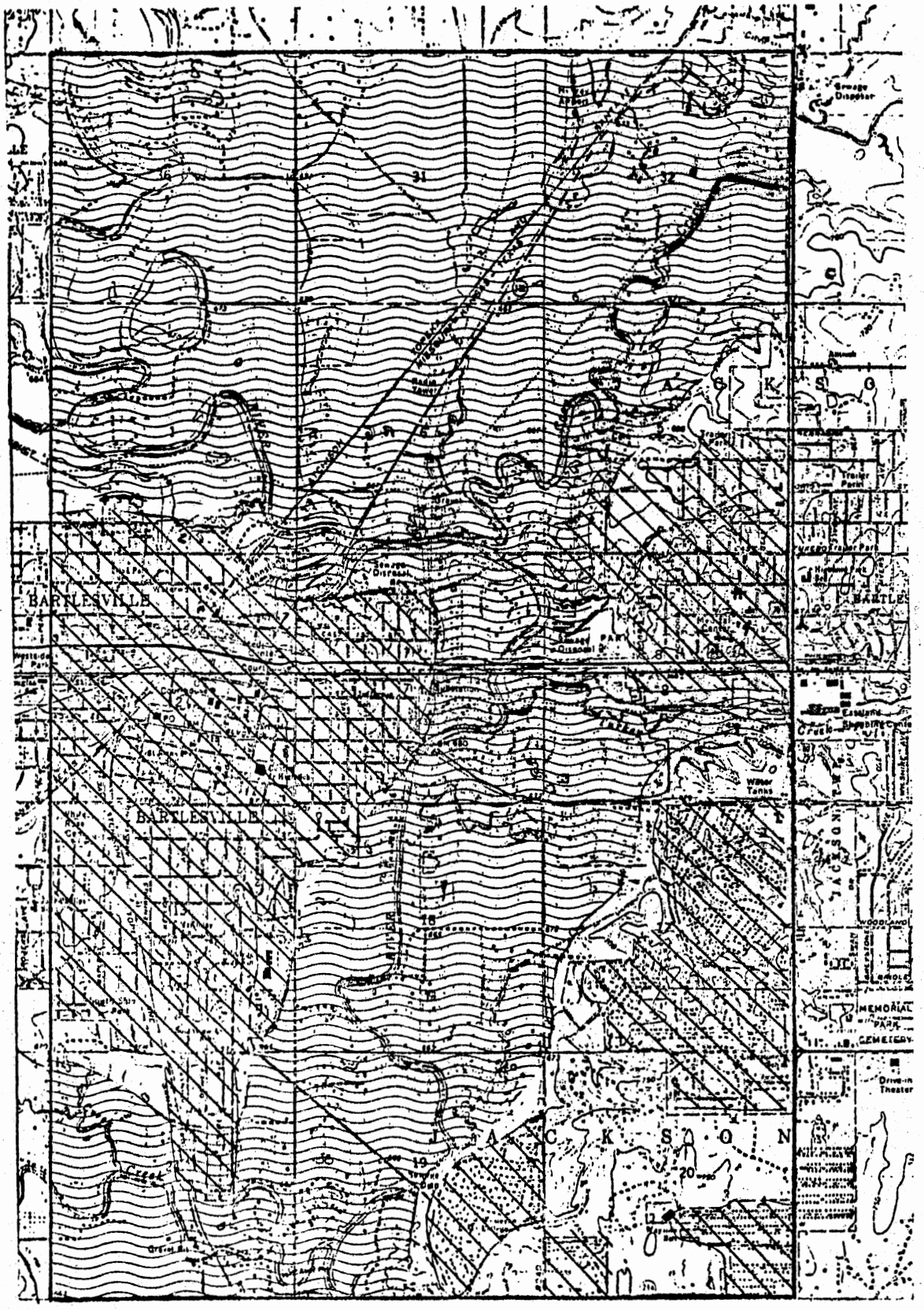


Figure 24. Caney River Flood Plain at Bartlesville, Oklahoma

appear in Appendix G. Figure 25 is a three-dimensional picture of the floodplain with a vertical exageration of three. Figure 26 is a topographic map of the area.

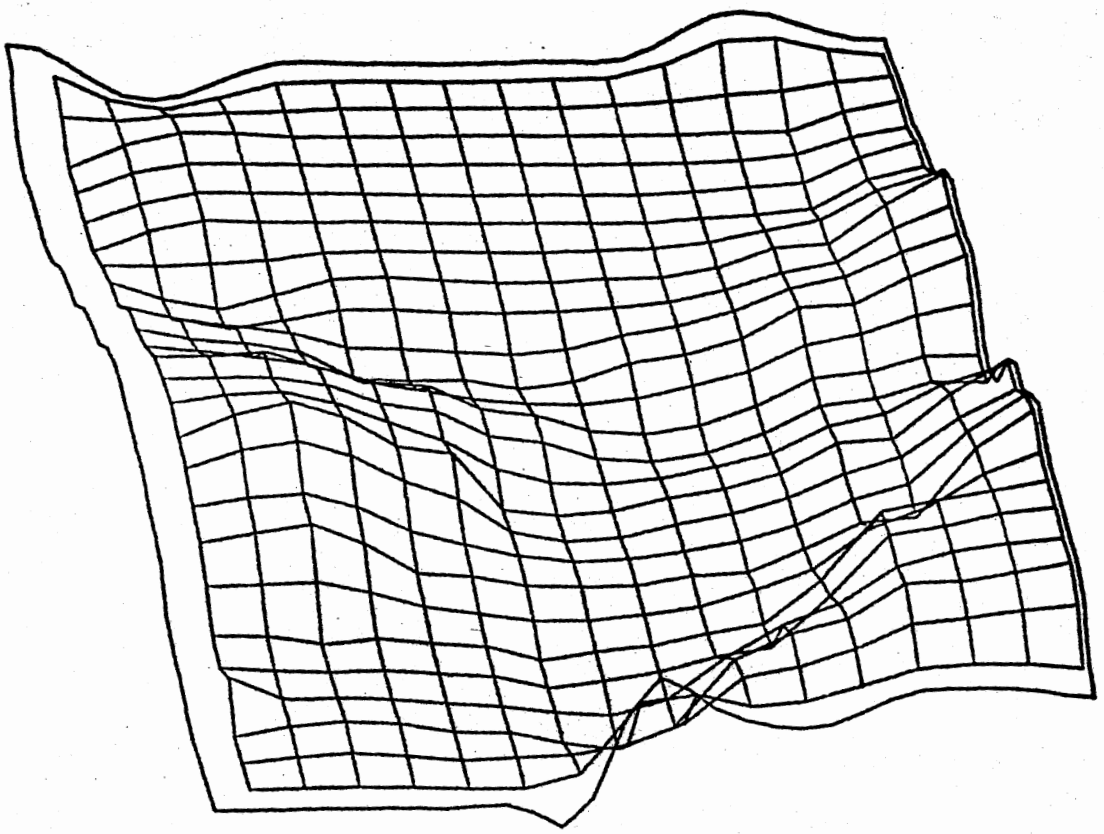


Figure 25. Flood Plain Three-Dimensional Representation

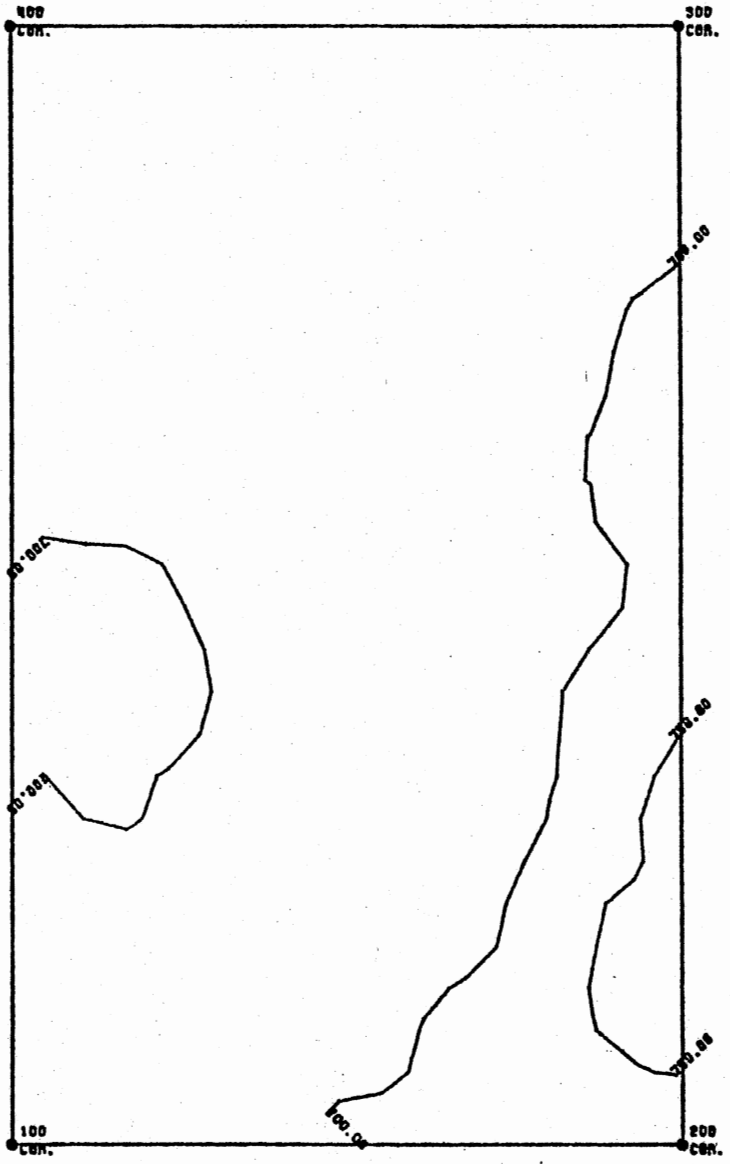


Figure 26. Flood Plain Topographic Map,
Fifty Foot Contour Interval

CHAPTER V

SUMMARY AND CONCLUSION

Applications and Degree of Accuracy

The numerical method of the horizontal and vertical calculations involved in housing subdivision design was investigated and applied in a FORTRAN IV source program. The program generates a data set of pen movements which provide plots of horizontal maps, contour maps, three-dimensional views, and selected profiles on the COMPLOT DP-8 drum plotter.

Within the scope of this study several concepts and ideas of various experts in the field of housing subdivision design were reported. The most important concepts to be reiterated are those of DeChiara and Koppelman (1978), who recommend a site inventory of soils, vegetation, hydrology, topography, and geology. A preliminary graphic analysis of topography, a vicinity sketch, preliminary sketch, grading plan, street and sewer profiles, and a final plat of the area may then be drawn. The computer program developed as a result of this research may be used to address any or all of these housing subdivision design criteria.

The overall degree of accuracy for the distances and bearings reported in the program is approximately $\pm$ .001 foot of distance and $\pm$ 1 second of angle for any distance, as the distances and bearings are calculated between previously stored points, not as the points are stored. Distances are reported on both the printout and the plot to the nearest .001 foot. It should be noted, however, that the distance shown on the

printout is rounded to this accuracy, while the distance shown on the plot is truncated to three decimal places. For the worst case, in which two lines are intersected, the accuracy of the bearing may be as low as ± two seconds for short distances.

As noted in Chapter III, horizontal intersections are performed iteratively (see Equation sequence (52)). In most cases, when it is desired to intersect two lines in a plane, the equation for each line is written, and the two equations are solved simultaneously for the X and Y coordinates of the point of intersection. It should be noted, however, that when this method is applied to intersect a line with a circle, two completely different solutions are possible for each X and Y coordinate. When intersections are made iteratively, this is avoided as the iterations are stopped when the first solution is obtained. Moreover, the mechanisms used for iteratively intersecting two lines (see Equation Sequence 52) are incorporated into other sections of the program (Equations 1 to 32, Table III), thus making the process a matter of transfer of control.

The accuracy of the iterative intersection process gives coordinates for the point being defined to ±.0001 feet. This causes no significant error in any distances. For relatively short distances (less than five feet), the angular error may reach several seconds. The angular error diminishes at longer distances.

In usual practice, traverse closure error is adjusted by a method which distributes the error according to the length of each line making up the traverse. Thus, long sides of a traverse will absorb more of the closure error than short sides. The method used for distributing traverse error in the program consists of adjusting each point by a fraction of

the number of points requiring adjustment (see Equations 37 to 44).

When the sides of a traverse are all approximately equal, the two methods give similar results. When the shortest side of a traverse is one hundred times smaller than the longest side, significantly different results are given by each method. The two methods yield a 35 percent difference in the length of the short side, while a three percent difference occurs in the length of the long side. The stated percent differences are approximate, with the differences decreasing with an increase in the number of points in the traverse.

In cases of actual housing subdivision design, it may be desired to adjust several of the points in a traverse while holding the remaining points from adjustment. This has particular value when the subdivision abuts existing or previously platted subdivisions. When this is desired, the method used in the program is particularly well applied, as the errors are distributed through a certain number of points, rather than a certain number of lines.

Additional Research

Additional research in the field of computer methods for subdivision design may be considered by the author in the future. The area of vertical street layout has no method for the calculation of earthwork incorporated within the program at this time. A method of relating the cut or fill of the street centerline at a station to the end area was investigated, as was relating the end area to the cut or fill at either side of the road. Neither method was acceptable as both methods gave approximate results, and in certain special cases, grossly inaccurate results. An

iterative method of generating end areas appears to be the most exact possibility of obtaining the volumes of cut and fill.

The three-dimensional plots shown in this study (Figures 20, 21, and 25) and the numerical method presently incorporated within the program to generate them allow lines hidden from view to be plotted. The land areas usually used for housing subdivision development are flat enough that few hidden lines occur. If this program is to be used for sophisticated terrain interpretation at any time in the future, some method of blanking hidden lines must be devised.

Finally, the use of the numerical method given in this study for applications in highway design is an interesting possibility. Certain aspects of the horizontal layout of a highway may be performed directly by the existing program. However, in order to adequately and accurately perform every calculation necessary for highway design, it would be necessary (and advisable) to deviate from the Cartesian coordinate system and use a station-offset method to define horizontal locations. The "view down the road" as seen by the driver could then be plotted with the three-dimensional plotting methods given in this paper (see Equations (55) and (56)). A blanking method to avoid plotting hidden lines would be required for this application also.

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APPENDIX A

HORIZONTAL CLOSURE AND TRAVERSE PRINTOUT

PT.NO.					PT.NO.					PT.NO.				
100	N	50.000	E	750.000	300	N	709.700	E	750.000	400	N	709.700	E	89.500
600	N	361.701	E	90.513	700	N	358.158	E	510.598	800	N	50.489	E	509.972

PT.NO.					PT.NO.					PT.NO.				
200	N	669.700	E	750.000	500	N	669.700	E	89.616	600	N	669.700	E	89.616

****
********** DISTANCES & BEARINGS **********
****

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
100	N 0- 0- 0. E	699.700	300	709.700	750.000
300	S 90- 0- 0. W	660.500	400	709.700	89.500
400	S 0-10- 0. E	348.000	600	361.701	90.513
600	S 89-31- 0. E	420.100	700	358.158	510.598
700	S 0- 7- 0. W	307.670	800	50.489	509.972
800	S 89-53- 0. E	240.029	100	50.000	750.000

****
********** DISTANCES & BEARINGS **********
****

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
200	S 90- 0- 0. W	660.384	500	669.700	89.616

LOTTING DATA

START POINT NO.	BEARING DEG. MIN. SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG. MIN. SEC.	ARC FT
		TRAVERSE	AREA						
100	N 0- 0- 0. E	619.700	180- 0- 0.	200	669.700	750.000			
200	N 0- 0- 0. E	40.000	90- 0- 0.	300	709.700	750.000			
300	S 90- 0- 0. W	660.500	89-59- 0.	400	709.700	89.500			
400	S 0-10- 0. E	40.000	179-59-59.	500	669.700	89.616			
500	S 0-10- 0. E	307.999	90-39- 0.	600	361.701	90.513			
600	S 89-31- 0. E	420.100	90-22- 0.	700	358.158	510.598			
700	S 0- 7- 0. W	307.670	90- 0- 0.	800	50.489	509.972			
800	S 89-53- 0. E	240.029	89-53- 0.	100	50.000	750.000			

AREA = 305081.03 FT**2 7.003697 ACRES
PERIMETER = 2535.997 FT

APPENDIX B

LOTTING AND TRAVERSE ADJUSTMENT PRINTOUT

PT.NO.					PT.NO.					PT.NO.				
9996	N	1417.398	E	102.299	9997	N	1277.398	E	102.055	9998	N	260.000	E	100.279
9999	N	100.000	E	100.000	9989	N	1261.610	E	603.025	9995	N	1437.172	E	852.659
9975	N	1197.459	E	852.276	9992	N	272.227	E	850.800	9977	N	282.703	E	1493.794
9978	N	422.684	E	1491.514	9979	N	426.757	E	1741.480	9980	N	286.775	E	1743.761
9981	N	290.848	E	1993.728	9982	N	344.954	E	2242.922	9984	N	382.422	E	2492.345
9983	N	349.027	E	2492.889	9972	N	386.804	E	2635.132	9991	N	142.957	E	2736.750
9974	N	347.777	E	2737.624	9985	N	334.665	E	2776.621	9990	N	389.954	E	2737.804
9986	N	614.856	E	2231.434	9993	N	1486.971	E	2742.483	9987	N	743.849	E	2056.686
9988	N	1056.897	E	1398.403	9969	N	1026.131	E	1517.936	9970	N	1122.865	E	1502.020
9971	N	1293.864	E	1534.198	9994	N	1450.695	E	1365.961	9994	N	1450.695	E	1365.961

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT.	END POINT	END POINT COORDS. NORTH	EAST
9999	N 89- 4- 0. E	2637.102	9991	142.957	2736.750
9999	N 0- 6- 0. E	160.000	9998	260.000	100.279
9998	N 0- 6- 0. E	1017.400	9997	1277.398	102.055
9997	N 0- 6- 0. E	140.000	9996	1417.398	102.299
9996	N 88-29-25. E	750.620	9995	1437.172	852.659
9995	S 0- 5-29. W	239.714	9975	1197.459	852.276
9975	N 75-34- 0. W	257.374	9989	1261.610	603.025
9975	S 0- 5-29. W	925.233	9992	272.227	850.800
9992	S 89- 4- 0. W	750.620	9998	260.000	100.279
9992	N 89- 4- 0. E	643.080	9977	282.703	1493.794
9977	N 0-56- 1. W	140.000	9978	422.684	1491.514
9978	N 89- 4- 0. E	250.000	9979	426.757	1741.480
9977	N 89- 4- 0. E	250.000	9980	286.775	1743.761
9979	S 0-56- 1. E	140.000	9980	286.775	1743.761
9980	N 89- 3-59. E	250.000	9981	290.848	1993.728
9981	N 77-44-59. E	255.000	9982	344.954	2242.922
9982	N 89- 3-59. E	250.000	9983	349.027	2492.889
9983	N 0-56- 1. W	33.400	9984	382.422	2492.345

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT.	END POINT	END POINT COORDS. NORTH	EAST
9984	N 88-14-33. E	142.855	9972	386.804	2635.132
9972	N 88-14-32. E	102.720	9990	389.954	2737.804
9990	S 0-14-40. W	42.177	9974	347.777	2737.624
9974	S 0-14-40. W	204.823	9991	142.957	2736.750
9990	N 0-14-40. E	1097.026	9993	1486.971	2742.483
9993	S 88-29-25. W	1377.001	9994	1450.695	1365.961
9994	S 88-29-27. W	513.480	9995	1437.172	852.659
9975	S 75-33-59. E	563.925	9988	1056.897	1398.403
9949	N 9-20-34. W	98.035	9970	1122.865	1502.020
9970	N 10-39-25. E	174.000	9971	1293.864	1534.198
9971	N 47- 0-34. W	230.000	9994	1450.695	1365.961
9987	S 53-33-59. E	217.200	9986	614.856	2231.434

CURVE DATA

CURVE DEFINED BY: PC	CC	PT	RADIUS FT.	CENTRAL ANGLE DEG.MIN.SEC.	ARC FT.	CHORD FT.	BEARING OF CHORD DEG.MIN.SEC.	TANGENT FT.	DEFLECTION ANGLE PER FT. OF ARC MIN.
9997	100	9989	1146.299	25-15-24.	505.300	501.219	S 88-11-42. E	256.822	1.499499168
9988	101	9987	1910.100	22- 0- 0.	733.425	728.928	S 64-33-59. E	371.285	0.899887057
9986	102	9972	1910.100	13-56-33.	464.805	463.660	S 60-32-15. E	233.556	0.899887370
9972	102	9974	1910.100	3-17-25.	109.685	109.670	S 69- 9-15. E	54.858	0.899887053
9974	102	9995	1910.100	1-14- 3.	41.143	41.142	S 71-24-57. E	20.572	0.899887184
9986	102	9974	1910.100	17-13-57.	574.490	572.328	S 62-10-58. E	289.430	0.899887142

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LOTTING DATA

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START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT.	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT.
			LOT NUMBER 29AC						
9996	N 88-29-25. E	750.620	88-23-56.	9995	1437.172	852.659			
9995	S 0- 5-29. W	239.714	180- 0- 0.	9975	1197.459	852.276			
9975	S 0- 5-29. W	925.233	91- 1-29.	9992	272.227	850.800			
9992	S 89- 4- 0. W	750.620	88-58- 0.	9998	260.000	100.279			
9998	N 0- 6- 0. E	1017.400	180- 0- 0.	9997	1277.398	102.055			
9997	N 0- 6- 0. E	140.000	91-36-34.	9996	1417.398	102.299			
AREA =	871358.62 FT**2		20.003641 ACRES						
PERIMETER =	3823.586 FT								
			LOT NUMBER ONE						
9995	N 88-29-27. E	513.480	179-59-59.	9994	1450.695	1365.961			
9994	N 88-29-25. E	1377.001	88-14-45.	9993	1486.971	2742.483			
9993	S 0-14-40. W	1097.026	92- 0- 7.	9990	389.954	2737.604			
9990	S 88-14-32. W	102.720	148-46-48.	9972	386.804	2635.132			
9972	N 60-32-15. W	463.660	173- 1-44.	9986	614.856	2231.434	1910.100	13-56-33.	464.805
9986	N 53-33-59. W	217.200	169- 0- 0.	9987	743.849	2056.686			
9987	N 64-33-59. W	728.928	169- 0- 0.	9988	1056.897	1398.403	1910.100	22- 0- 0.	733.425
9988	N 75-33-59. W	563.925	104-20-31.	9975	1197.459	852.276			
9975	N 0- 5-29. E	239.714	91-36- 2.	9995	1437.172	852.659			
ARC AREA =	4368.891								
ARC AREA =	-17086.473								
AREA =	1177393.48 FT**2		27.029235 ACRES						
PERIMETER =	5309.289 FT								

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT.	END POINT	END POINT COORDS. NORTH	EAST
9948	N 9-20-34. W	101.337	9957	1122.720	1514.712
9957	N 10-39-25. E	176.677	9963	1298.315	1547.755
9963	N 47- 0-34. W	224.161	9962	1451.165	1383.788
9961	S 47- 0-34. E	235.839	9967	1289.413	1520.641
9967	S 10-39-25. W	169.323	9951	1123.011	1489.328
9951	S 9-20-35. E	94.732	9950	1029.536	1504.707

PT.NO.				PT.NO.				PT.NO.			
9962	N	1451.165	E 1383.788	9961	N	1450.225	E 1348.133	9967	N	1289.413	E 1520.641
9963	N	1298.315	E 1547.755	9957	N	1122.720	E 1514.712	9951	N	1123.011	E 1489.328
9950	N	1029.536	E 1504.707	9948	N	1022.726	E 1531.164	9948	N	1022.726	E 1531.164

LOTTING DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT.	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT.
		LOT NUMBER TWOA							
9975	S 75-33-59. E	563.925	169- 0- 0.	9988	1056.897	1398.403			
9988	S 64-33-59. E	728.928	70-36-16.	9987	743.849	2056.686	1910.100	22- 0- 0.	733.425
9987	S 44-49-45. W	447.104	135-45-45.	9979	426.757	1741.480			
9979	S 89- 4- 0. W	250.000	90- 0- 0.	9978	422.684	1491.514			
9978	S 0-56- 1. E	140.000	90- 0- 0.	9977	282.703	1493.794			
9977	S 89- 4- 0. W	643.080	88-58-30.	9992	272.227	850.800			
9992	N 0- 5-29. E	925.237	75-39-28.	9975	1197.459	852.276			
ARC AREA =		17086.473							
AREA =	758192.95 FT**2		17.405715 ACRES						
PERIMETER =	3702.767 FT								
		LOT NUMBER TWOB							
9987	S 44-49-45. W	447.104	134-14-14.	9979	426.757	1741.480			
9979	S 0-56- 1. E	140.000	90- 0- 0.	9980	286.775	1743.761			
9980	N 89- 3-59. E	250.000	168-41- 0.	9981	290.848	1993.728			
9981	N 77-44-59. E	255.000	168-41- 0.	9982	344.954	2242.922			
9982	N 89- 3-59. E	250.000	90- 0- 0.	9983	349.027	2492.889			
9983	N 0-56- 1. W	33.400	90-49-26.	9984	382.422	2492.345			
9984	N 88-14-33. E	142.855	31-13-12.	9972	386.604	2635.132			
9972	N 60-32-15. W	463.660	173- 1-44.	9986	614.856	2231.434	1910.100	13-56-33.	464.805
9986	N 53-33-59. W	217.200	98-23-44.	9987	743.849	2056.686			
ARC AREA =		-4368.891							
AREA =	207340.15 FT**2		4.759875 ACRES						
PERIMETER =	2200.363 FT								

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********** LOTTING DATA **********

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START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT.	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT.
		LOT NUMBER ESMT							
9980	S 89- 4- 0. W	250.000	90- 0- 0.	9977	282.703	1493.794			
9977	N 0-56- 1. W	140.000	90- 0- 0.	9978	422.684	1491.514			
9978	N 89- 4- 0. E	250.000	90- 0- 0.	9979	426.757	1741.480			
9979	S 0-56- 1. E	140.000	90- 0- 0.	9980	286.775	1743.761			
AREA =	35000.00 FT**2	0.803489 ACRES							
PERIMETER =	779.999 FT								
		LOT NUMBER SH33							
9998	N 89- 4- 0. E	750.620	180- 0- 0.	9992	272.227	850.800			
9992	N 89- 4- 0. E	643.080	180- 0- 0.	9977	282.703	1493.794			
9977	N 89- 4- 0. E	250.000	180- 0- 0.	9980	286.775	1743.761			
9980	N 89- 3-59. E	250.000	168-41- 0.	9981	290.848	1993.728			
9981	N 77-44-59. E	255.000	168-41- 0.	9982	344.954	2242.922			
9982	N 89- 3-59. E	250.000	90- 0- 0.	9983	349.027	2492.889			
9983	N 0-56- 1. W	33.400	90-49-26.	9984	382.422	2492.345			
9984	N 88-14-33. E	245.575	87-59-53.	9990	389.954	2737.804			
9990	S 0-14-40. W	247.000	91-10-40.	9991	142.957	2736.750			
9991	S 89- 4- 0. W	2637.102	88-58- 0.	9999	100.000	100.000			
9999	N 0- 6- 0. E	160.000	91- 2- 0.	9998	260.000	100.279			
AREA =	461511.81 FT**2	10.594853 ACRES							
PERIMETER =	5721.770 FT								

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********** STREET CENTERLINES FOR STATIONING **********
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START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	RADIUS FT.	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT.
		LOT NUMBER OL33							
9997	S 88-11-42. E	501.219	167-22-18.	9989	1261.610	603.025	1146.299	25-15-24.	505.300
9989	S 75-34- 0. E	257.374	180- 0- 0.	9975	1197.459	852.276			
9975	S 75-33-59. E	687.354	0- 0- 1.	9949	1026.131	1517.936			
9949	N 75-33-58. W	123.428	10-59-59.	9988	1056.897	1398.403			
9988	S 64-33-59. E	728.928	169- 0- 0.	9987	743.849	2056.686	1910.100	22- 0- 0.	733.425
9987	S 53-33-59. E	217.200	50- 2-30.	9986	614.856	2231.434			
		LOT NUMBER OL33							
9987	S 53-33-59. E	217.200	173- 1-44.	9986	614.856	2231.434			
9986	S 60-32-15. E	463.660	171-23- 0.	9972	386.804	2635.132	1910.100	13-56-33.	464.805
9972	S 69- 9-15. E	109.670	177-44-18.	9974	347.777	2737.624	1910.100	3-17-25.	109.685
9974	S 71-24-57. E	41.142	25-27-25.	9985	334.665	2776.621	1910.100	1-14- 3.	41.143

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********** STREET CENTEFLINES FOR STATIONING **********
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START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	RADIUS FT.	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT.
		LOT NUMBER ROAD							
9994	S 47- 0-34. E	233.000	122-20- 0.	9971	1293.864	1534.198			
9971	S 10-39-25. W	174.000	160- 0- 0.	9970	1122.865	1502.020			
9970	S 9-20-34. E	98.035	12-49- 8.	9949	1026.131	1517.936			

********** LOTTING DATA **********

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	RADIUS FT.	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT.
			LOT NUMBER AREA						
9996	N 88-29-26. E	2641.101	88-14-46.	9993	1486.971	2742.483			
9993	S 0-14-40. W	1097.026	92- 0- 7.	9990	389.954	2737.804			
9990	S 38-14-33. W	245.575	90-49-26.	9984	382.422	2492.345			
9984	S 0-56- 1. E	33.400	90- 0- 0.	9983	349.027	2492.889			
9983	S 89- 3-59. W	250.000	168-41- 0.	9982	344.954	2242.922			
9982	S 77-44-59. W	255.000	168-41- 0.	9981	290.848	1993.728			
9981	S 89- 4- 0. W	1893.699	88-58- 0.	9998	260.000	100.279			
9998	N 0- 6- 0. E	1157.401	91-36-34.	9996	1417.398	102.299			
AREA = 3049286.26 FT**2 70.001980 ACRES									
PERIMETER = 7573.195 FT									
			LOT NUMBER ROAD						
9962	S 47- 0-34. E	224.161	122-20- 0.	9963	1298.315	1547.755			
9963	S 10-39-25. W	178.677	160- 0- 0.	9957	1122.720	1514.712			
9957	S 9-20-34. E	101.337	66-13-25.	9948	1022.726	1531.164			
9948	N 75-33-59. W	27.319	113-46-35.	9950	1029.536	1504.707			
9950	N 9-20-35. W	94.732	160- 0- 0.	9951	1123.011	1489.328			
9951	N 10-39-25. E	169.323	122-20- 0.	9967	1289.413	1520.641			
9967	N 47- 0-34. W	235.839	44-30- 0.	9961	1450.225	1348.133			
9961	N 88-29-25. E	35.668	135-30- 0.	9962	1451.165	1383.788			
AREA = 12550.87 FT**2 0.288128 ACRES									
PERIMETER = 1067.055 FT									

APPENDIX C

SMALL SUBDIVISION TEST PROBLEM PRINTOUT

ADJUSTED TRAVERSE DATA

START POINT NO.	HORIZONTAL LINE DATA: BEARING DEG.MIN SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	END POINT COORDS. EAST	HORIZONTAL CURVE DATA: RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE ONE							
101	N 0- 0- 0. E	330.000	86-12-21.	104	100.000	50.000			
104	N 86-12-21. E	303.794	93-57-14.	108	120.102	353.128			
108	N 0- 9-35. E	299.406	91-49- 2.	111	419.507	353.963			
111	N 88- 1-22. W	304.144	88- 1-22.	101	430.000	50.000			

AREA = 95524.54 FT**2
PERIMETER = 1237.344 FT
2.192942 ACRES

PT.NO.				PT.NO.				PT.NO.			
101	N	430.000	E 50.000	102	N	300.000	E 50.000	103	N	200.000	E 50.000
104	N	100.000	E 50.000	105	N	107.738	E 166.688	106	N	109.727	E 196.678
107	N	111.716	E 226.668	108	N	120.102	E 353.128	109	N	220.102	E 353.407
110	N	320.101	E 353.686	111	N	419.507	E 353.963	112	N	424.593	E 195.058
113	N	358.934	E 195.398	114	N	299.373	E 135.709	115	N	246.820	E 165.974
116	N	204.072	E 166.193	117	N	227.379	E 226.675	118	N	247.128	E 225.973
119	N	306.902	E 255.176	120	N	298.935	E 195.787	121	N	119.073	E 166.630
122	N	127.381	E 226.588	123	N	227.225	E 196.075	124	N	204.226	E 196.193

CURVE DATA

CURVE DEFINED BY: PC	CC	PT	RADIUS FT	CENTRAL ANGLE DEG.MIN.SEC.	ARC FT	CHORD FT	BEARING OF CHORD DEG.MIN.SEC.	TANGENT FT	DEFLECTION ANGLE PER FT OF ARC MIN.
115	120	114	60.000	60-42-47.	63.578	60.645	N 29-56-15. W	35.141	28.647924710
114	120	113	60.000	89-17- 9.	93.500	84.322	N 45- 3-43. E	59.257	28.647920102
113	120	119	60.000	82-39-49.	86.565	79.250	S 48-57-47. E	52.770	28.647920617
119	120	118	60.000	67-20-14.	70.515	66.527	S 25- 2-14. W	39.968	28.647921019

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
101	N 0- 0- 0. E	130.000	102	300.000	50.000
102	S 89-34-52. E	85.711	114	299.373	135.709
102	N 0- 0- 0. E	100.000	103	200.000	50.000
103	N 67-59-35. E	116.265	116	204.072	166.193
116	N 0-17-39. W	42.749	115	246.820	165.974
116	S 0-17-39. E	96.335	105	107.738	166.688
103	N 0- 0- 0. E	100.000	104	100.000	50.000
104	N 86-12-22. E	116.944	105	107.738	166.688
105	N 86-12-20. E	30.056	106	109.727	196.678
106	N 0-17-38. W	94.500	124	204.226	196.193
124	N 0-17-38. W	23.000	123	227.225	196.075
123	N 0-17-38. W	71.710	120	298.935	195.707
118	S 0-17-38. E	19.748	117	227.379	226.075
117	S 0-17-38. E	115.665	107	111.716	226.668
106	N 86-12-23. E	30.056	107	111.716	226.668
107	N 86-12-21. E	126.738	108	120.102	353.128
108	N 0- 9-35. E	100.000	109	220.102	353.407
117	S 86-43-43. E	127.540	109	220.102	353.407
109	N 0- 9-35. E	100.000	110	320.101	353.686
119	N 82-22- 7. E	99.390	110	320.101	353.686
110	N 0- 9-35. E	99.406	111	419.507	353.963
111	N 88- 1-22. W	159.000	112	424.993	195.058
113	N 0-17-42. W	66.060	112	424.993	195.058
112	N 88- 1-23. W	145.144	101	430.000	50.000

LOTTING DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE 1							
117	S 0-17-38. E	115.665	86-29-59.	107	111.716	226.668			
107	N 86-12-21. E	126.738	93-57-14.	108	120.102	353.128			
108	N 0- 9-35. E	100.000	93- 6-41.	109	220.102	353.407			
109	N 86-43-43. W	127.540	86-26- 5.	117	227.379	226.075			
AREA =		13683.50 FT**2	0.314130 ACRES						
PERIMETER =		469.543 FT							
		TRAVERSE 2							
117	S 86-43-43. E	127.540	86-53-18.	109	220.102	353.407			
109	N 0- 9-35. E	100.000	82-12-32.	110	320.101	353.686			
110	S 82-22- 7. W	99.390	123-40- 7.	119	306.902	255.176			
119	S 26- 2-14. W	66.527	153-40- 7.	118	247.128	225.973	60.000	67-20-14.	70.515
118	S 0-17-38. E	19.748	93-33-55.	117	227.379	226.675			
ARC AREA =		-454.441							
AREA =		9929.40 FT**2	0.227948 ACRES						
PERIMETER =		417.194 FT							
		TRAVERSE 3							
111	S 0- 9-35. W	99.406	97-47-27.	110	320.101	353.686			
110	S 82-22- 7. W	99.390	131-19-55.	119	306.902	255.176			
119	N 48-57-47. W	79.250	131-19-55.	113	358.934	195.398	60.000	82-39-49.	86.365
113	N 0-17-42. W	66.060	87-43-40.	112	424.993	195.058			
112	S 88- 1-22. E	159.000	91-49- 2.	111	419.507	353.963			
ARC AREA =		-811.691							
AREA =		15266.02 FT**2	0.350460 ACRES						
PERIMETER =		510.422 FT							

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LOTTING CATA
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START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
			TRAVERSE 4						
101	N 0- 0- 0. E	130.000	90-25- 8.	102	300.000	50.000			
102	S 89-34-52 E	85.711	134-38-34.	114	299.373	135.709			
114	N 45- 3-43. E	84.322	134-38-34.	113	358.934	195.328	60.000	89-17- 9.	93.500
113	N 0-17-42 W	66.060	92-16-26.	112	424.993	195.056			
112	N 88- 1-23. W	145.144	88- 1-23.	101	430.000	50.000			
ARC AREA =		-1005.133							
AREA =		15607.18 FT**2	0.362883 ACRES						
PERIMETER =		520.414 FT							
			TRAVERSE 5						
116	N 0-17-39. W	42.749	150-21-24.	115	246.820	165.674			
115	N 29-56-15. W	60.645	120-21-23.	114	299.373	135.709	60.000	60-42-47.	63.578
114	N 89-34-52. W	85.711	89-34-52.	102	300.000	50.000			
102	N 0- 0- 0. E	100.000	87-59-35.	103	200.000	50.000			
103	N 87-59-35. E	116.265	91-42-47.	116	204.072	166.193			
ARC AREA =		-337.428							
AREA =		10167.89 FT**2	0.233382 ACRES						
PERIMETER =		408.302 FT							
			TRAVERSE 6						
116	S 87-59-35. W	116.265	92- 0-25.	103	200.000	50.000			
103	N 0- 0- 0. E	100.000	86-12-22.	104	100.000	50.000			
104	N 86-12-22. E	116.944	93-30- 0.	105	107.738	166.688			
105	N 0-17-39. W	96.335	88-17-13.	116	204.072	166.193			
AREA =		11432.07 FT**2	0.262444 ACRES						
PERIMETER =		429.543 FT							

APPENDIX D

TRIANGULATION EXAMPLE, OKLAHOMA STATE UNIVERSITY SURVEYING TRAVERSE PRINTOUT

********** OKLAHOMA STATE UNIVERSITY SURVEYING TRAVERSE **********
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NOTE: THE BEARING OF LINE 1-2 IS BASED ON AN OBSERVATION MADE ON SEPTEMBER 20, 1978 AND SHOULD BE INTERPRETED AS AN APPROXIMATE BEARING. THUS, ALL BEARINGS FOUND ON THIS OUTPUT ARE APPROXIMATE, BUT ARE CORRECT RELATIVE TO EACH OTHER.

********** ADJUSTED TRAVERSE DATA **********

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA: RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE A							
1	N 29-50- 0. W	269.015	90-32-45.	2	283.364	41.171			
2	N 59-37-15. E	239.063	48-13-28.	4	404.262	247.410			
4	S 11-23-48. W	203.873	175-38-38.	10	204.410	207.125			
10	S 11-45-10. W	157.716	41-35-10.	1	50.000	175.000			

AREA = 32254.18 FT**2 0.740454 ACRES
PERIMETER = 869.666 FT

********** ADJUSTED TRAVERSE DATA **********

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA: RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE B							
4	S 59-37-15. W	239.063	46-19-53.	2	283.364	41.171			
2	N 13-17-23. E	270.345	117-27-28.	3	546.470	103.316			
3	N 75-49-54. E	208.131	59-11-51.	5	597.413	305.116			
5	S 16-38- 3. W	201.587	137- 0-47.	4	404.262	247.410			

AREA = 41393.70 FT**2 0.950269 ACRES
PERIMETER = 919.125 FT

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE C							
4	S 11-23-48. W	203.873	61-10-24.	10	204.410	207.125			
10	N 72-34-12. E	204.135	138-26- 9.	6	265.556	401.886			
6	N 31- 0-20. E	163.210	58-42-36.	7	405.446	485.960			
7	S 89-42-57. W	238.553	101-40-51.	4	404.262	247.410			
AREA = 34865.79 FT**2 0.800468 ACRES									
PERIMETER = 809.770 FT									

****
ADJUSTED TRAVERSE DATA
****

HORIZONTAL LINE DATA — HORIZONTAL CURVE DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE D							
7	S 89-42-57. W	238.553	73- 4-54.	4	404.262	247.410			
4	N 16-38- 3. E	201.587	139-51-43.	5	597.413	305.116			
5	N 56-46-20. E	182.172	62-20-32.	8	697.238	457.502			
8	S 5-34-13. E	293.177	84-42-51.	7	405.446	485.960			
AREA = 46656.88 FT**2 1.071095 ACRES									
PERIMETER = 915.488 FT									

****
ADJUSTED TRAVERSE DATA
****

HORIZONTAL LINE DATA — HORIZONTAL CURVE DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE E							
6	N 31- 0-20. E	163.210	82-44- 8.	7	405.446	485.960			
7	S 51-43-47. E	273.628	32-37- 1.	9	235.969	700.785			
9	N 84-20-48. W	300.359	64-38-51.	6	265.556	401.886			
AREA = 22150.18 FT**2 0.508498 ACRES									
PERIMETER = 737.197 FT									

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
1	N 29-50- 0. W	269.015	2	283.364	41.171
2	S 64-33-24. E	183.779	10	204.410	207.125
10	S 11-45-10. W	157.716	1	50.000	175.000
10	N 16-52-55. W	357.465	3	546.470	103.316
3	S 13-17-23. W	270.345	2	283.364	41.171
2	N 59-37-15. E	239.063	4	404.262	247.410
4	S 11-23-48. W	203.873	10	204.410	207.125
10	N 72-34-12. E	204.135	6	265.556	401.886
6	N 48- 4-44. W	207.611	4	404.262	247.410
4	N 89-42-57. E	238.653	7	405.446	485.960
7	S 31- 0-20. W	163.210	6	265.556	401.886
6	N 16-15-24. W	345.679	5	597.413	305.116
5	S 75-49-54. W	208.131	3	546.470	103.316
3	S 45-22-39. E	202.450	4	404.262	247.410
4	N 16-38- 3. E	201.587	5	597.413	305.116
5	N 56-46-20. E	182.172	8	697.238	457.502
8	S 35-38-39. W	360.518	4	404.262	247.410
5	S 43-17-27. E	263.735	7	405.446	485.960
7	N 5-34-13. W	293.177	8	697.238	457.502
8	S 27-48-29. E	521.494	9	235.969	700.785
9	N 51-43-47. W	273.628	7	405.446	485.960
6	S 84-20-48. E	300.359	9	235.969	700.785

		TRAVERSE	AREA			
1	N 29-50- 0. W	269.015	136-52-37.	2	283.364	41.171
2	N 13-17-23. E	270.345	117-27-28.	3	546.470	103.316
3	N 75-49-54. E	208.131	166-56-25.	5	597.413	305.116
5	N 56-46-20. E	182.172	84-34-48.	8	697.238	457.502
8	S 27-48-29. E	521.494	56-32-20.	9	235.969	700.785
9	N 84-20-48. W	300.359	156-55- 0.	6	265.556	401.886
6	S 72-34-12. W	204.135	119-10-58.	10	204.410	207.125
10	S 11-45-10. W	157.716	41-35-10.	1	50.000	175.000

AREA = 206251.46 FT**2 4.734882 ACRES
PERIMETER = 2113.365 FT

PT.NO.				PT.NO.				PT.NO.			
1	N	50.000	E 175.000	2	N	283.364	E 41.171	3	N	546.470	E 103.316
4	N	404.262	E 247.410	5	N	597.413	E 305.116	6	N	265.556	E 401.886
7	N	405.446	E 485.566	8	N	697.238	E 457.502	9	N	235.969	E 700.785
10	N	204.410	E 207.125	10	N	204.410	E 207.125	1	N	50.000	E 175.000

LOTTING DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	END POINT COORDS. EAST	HORIZONTAL CURVE DATA: RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE 1							
1	N 29-50- 0. W	269.015	34-43-24.	2	283.364	41.171			
2	S 64-33-24. E	183.779	103-41-26.	10	204.410	207.125			
10	S 11-45-10. W	157.716	41-35-10.	1	50.000	175.000			
AREA = 14080.64 FT**2 0.323247 ACRES PERIMETER = 610.509 FT									
		TRAVERSE 2							
10	N 64-33-24. W	183.779	55-49-21.	2	283.364	41.171			
2	N 59-37-15. E	239.063	48-13-28.	4	404.262	247.410			
4	S 11-23-48. W	203.873	75-57-12.	10	204.410	207.125			
AREA = 18173.54 FT**2 0.417207 ACRES PERIMETER = 626.714 FT									
		TRAVERSE 3							
2	N 13-17-23. E	270.345	58-40- 2.	3	546.470	103.316			
3	S 45-22-39. E	202.450	75- 0- 5.	4	404.262	247.410			
4	S 59-37-15. W	239.063	46-19-53.	2	283.364	41.171			
AREA = 23374.68 FT**2 0.536609 ACRES PERIMETER = 711.857 FT									
		TRAVERSE 4							
4	N 45-22-39. W	202.450	58-47-26.	3	546.470	103.316			
3	N 75-49-54. E	208.131	59-11-51.	5	597.413	305.116			
5	S 16-38- 3. W	201.587	62- 0-42.	4	404.262	247.410			
AREA = 18019.02 FT**2 0.413660 ACRES PERIMETER = 612.167 FT									

LOTTING DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
			TRAVERSE 5						
10	N 11-23-48. E	203.873	59-28-32.	4	404.262	247.410			
4	S 48- 4-44. E	207.611	59-21- 4.	6	265.556	401.886			
6	S 72-34-12. W	204.135	61-10-24.	10	204.410	207.125			
AREA = 18230.19 FT**2 0.418508 ACRES PERIMETER = 615.618 FT									
			TRAVERSE 6						
4	S 48- 4-44. E	207.611	75- 5- 4.	6	265.556	401.886			
6	N 31- 0-20. E	163.210	88-42-36.	7	405.446	485.960			
7	S 89-42-57. W	238.553	42-12-19.	4	404.262	247.410			
AREA = 16635.60 FT**2 0.381901 ACRES PERIMETER = 609.374 FT									
			TRAVERSE 7						
4	N 16-38- 3. E	201.587	59-55-30.	5	597.413	305.116			
5	S 43-17-27. E	263.735	46-59-36.	7	405.446	485.960			
7	S 89-42-57. W	238.553	73- 4-54.	4	404.262	247.410			
AREA = 23003.91 FT**2 0.528097 ACRES PERIMETER = 703.874 FT									

		TRAVERSE 8				
6	N 31- 0-20. E	163.210	82-44- 8.	7	405.446	485.960
7	S 51-43-47. E	273.628	32-37- 1.	9	235.969	700.785
9	N 84-20-48. W	300.359	64-38-51.	6	265.556	401.886

AREA = 22150.18 FT**2 0.508498 ACRES
PERIMETER = 747.197 FT

		TRAVERSE 9				
7	N 5-34-13. W	293.177	22-14-16.	8	697.238	457.502
8	S 27-48-29. E	521.494	23-55-16.	9	235.969	700.785
9	N 51-43-47. W	273.628	133-50-25.	7	405.446	485.960

AREA = 28930.74 FT**2 0.664158 ACRES
PERIMETER = 1098.299 FT

		TRAVERSE 10				
5	N 56-46-20. E	182.172	62-20-32.	8	697.238	457.502
8	S 5-34-13. E	293.177	37-43-15.	7	405.446	485.960
7	N 43-17-27. W	263.735	79-56-13.	5	597.413	305.116

AREA = 23652.97 FT**2 0.542997 ACRES
PERIMETER = 739.083 FT

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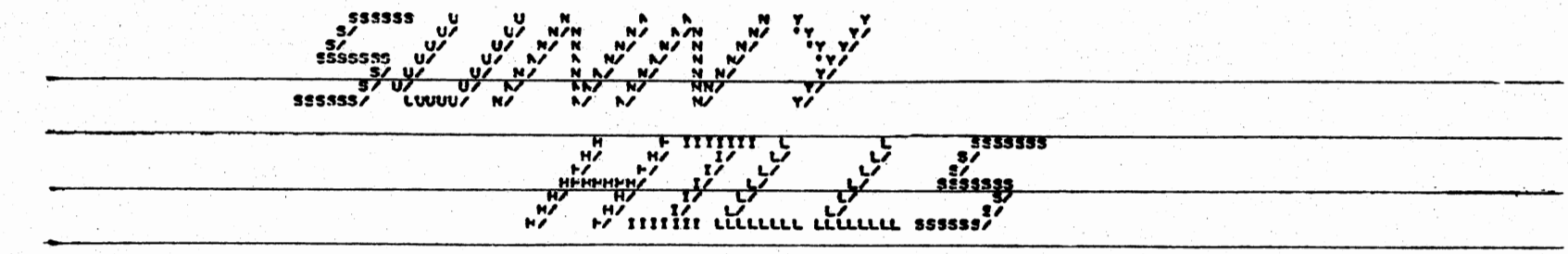
LOTTING DATA
****

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE A23							
4	S 11-23-48. W	203.873	28-16-43.	10	204.410	207.125			
10	N 16-52-55. W	357.465	28-29-44.	3	546.470	103.316			
3	S 45-22-39. E	202.450	123-13-33.	4	404.262	247.410			
AREA = 17263.18 FT**2 0.396308 ACRES PERIMETER = 763.787 FT									
		TRAVERSE A67							
4	N 16-38- 3. E	201.587	32-53-27.	5	597.413	305.116			
5	S 16-15-24. E	345.679	31-49-19.	6	265.556	401.886			
6	N 48- 4-44. W	207.611	115-17-13.	4	404.262	247.410			
AREA = 18920.75 FT**2 0.434361 ACRES PERIMETER = 754.876 FT									
		TRAVERSE A710							
5	N 56-46-20. E	182.172	21- 7-40.	8	697.238	457.502			
8	S 35-38-39. W	360.518	19- 0-36.	4	404.262	247.410			
4	N 16-38- 3. E	201.587	139-51-43.	5	597.413	305.116			
AREA = 11836.54 FT**2 0.271730 ACRES PERIMETER = 744.277 FT									
		TRAVERSE B710							
7	S 89-42-57. W	238.553	54- 4-17.	4	404.262	247.410			
4	N 35-38-39. E	360.518	41-12-52.	8	697.238	457.502			
8	S 5-34-13. E	293.177	84-42-51.	7	405.446	485.960			
AREA = 34820.33 FT**2 0.799365 ACRES PERIMETER = 892.247 FT									

APPENDIX E

COMPLETE HOUSING SUBDIVISION PRINTOUT



PT.NO.					PT.NO.					PT.NO.				
9990	N	1420.900	E	1420.000	1701	N	1400.804	E	1387.000	9986	N	1040.000	E	1420.000
1305	N	890.902	E	1420.000	1409	N	316.000	E	1420.000	5989	N	168.000	E	1420.000
1708	N	119.902	E	1386.999	1707	N	116.080	E	101.409	1706	N	96.140	E	121.277
1705	N	411.074	E	123.358	9974	N	491.072	E	103.887	1704	N	521.071	E	124.085
1703	N	1417.147	E	130.005	1702	N	1397.090	E	105.873	9980	N	1120.071	E	558.725
9981	N	828.242	E	521.904	9976	N	872.644	E	954.362	9982	N	975.172	E	1029.309
9984	N	1040.000	E	1157.000	9985	N	1040.000	E	1387.000	9979	N	638.526	E	783.223
9975	N	596.828	E	752.742	9978	N	560.500	E	726.186	9974	N	494.323	E	622.463
9976	N	491.073	E	589.437	9973	N	491.072	E	379.887	9975	N	491.072	E	373.887

PT.NO.					PT.NO.					PT.NO.				
1801	N	1420.659	E	1337.000	1802	N	1119.759	E	1337.001	1803	N	1120.000	E	1157.000
1804	N	1022.382	E	964.724	1805	N	942.989	E	906.685	1806	N	1144.715	E	655.641
1807	N	1200.963	E	617.517	1808	N	1161.245	E	467.595	1809	N	1039.178	E	499.934
1810	N	1020.122	E	555.526	1811	N	813.820	E	812.267	1812	N	607.710	E	661.602
1813	N	571.073	E	589.437	1814	N	571.070	E	104.415	1815	N	411.074	E	103.358
1816	N	411.073	E	589.437	1817	N	513.289	E	790.770	1818	N	927.961	E	1093.893
1819	N	960.000	E	1157.000	1820	N	959.759	E	1237.001	1821	N	99.753	E	1337.000

PT.NO.				PT.NO.				PT.NO.			
101	N	1420.804	E 1387.000	10	N	1070.000	E 1387.000	11	N	1070.000	E 1157.000
104	N	1419.995	E 1109.001	21	N	992.876	E 1085.090	209	N	1354.313	E 728.969
205	N	1419.027	E 776.003	31	N	871.272	E 916.198	32	N	1118.362	E 608.696
33	N	1160.517	E 588.121	41	N	1149.658	E 513.160	404	N	1323.091	E 109.384
9987	N	1417.089	E 110.005	51	N	1079.624	E 529.330	502	N	929.974	E 420.565
503	N	930.125	E 376.752	504	N	931.062	E 106.754	61	N	1071.640	E 571.153
62	N	822.834	E 880.790	63	N	657.336	E 759.813	71	N	578.204	E 701.967
9977	N	660.463	E 589.437	72	N	521.073	E 585.437	73	N	521.072	E 374.085
81	N	521.071	E 104.085	92	N	461.073	E 103.685	91	N	461.073	E 379.688
909	N	96.902	E 377.276	9988	N	96.081	E 101.277	109	N	461.073	E 589.437
110	N	464.899	E 628.312	1009	N	97.865	E 701.274	1199	N	542.796	E 750.405
111	N	506.467	E 723.849	1109	N	404.141	E 1016.323	1102	N	368.340	E 989.060
1103	N	98.108	E 783.274	120	N	853.837	E 977.775	1209	N	663.535	E 1214.161
131	N	957.467	E 1053.528	9983	N	881.830	E 1157.000	132	N	1010.000	E 1157.000
133	N	1010.000	E 1387.000	1302	N	890.902	E 1387.000	1402	N	315.902	E 1387.000
1407	N	314.936	E 1062.117	1502	N	99.902	E 1387.000	9989	N	100.000	E 1420.000

DISTANCES & BEARINGS

POINT NO.	BEARING DEG. MIN. SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
9990	N 0- 0- 0. E	380.900	9986	1040.000	1420.000
9986	N 0- 0- 0. E	149.098	1309	890.902	1420.000
1309	N 0- 0- 0. E	574.902	1409	316.000	1420.000
1409	N 0- 0- 0. E	216.000	9989	100.000	1420.000
1705	S 89-49-47. W	1285.596	1707	116.080	101.409
1706	N 0-22-43. E	314.940	1705	411.074	123.358
1704	N 0-22-43. E	896.095	1703	1417.147	130.005
1702	N 89-50- 0. E	1277.132	1701	1400.804	1387.000
9986	S 90- 0- 0. W	33.000	9985	1040.000	1387.000
9985	S 90- 0- 0. W	230.000	9984	1040.000	1157.000
9982	S 36-10- 0. W	127.000	9876	872.644	954.362
9876	S 36-10- 0. W	55.000	9981	828.242	921.904
9981	N 51-13- 0. W	465.900	9980	1120.071	558.725
9981	S 36-10- 0. W	235.000	9979	638.526	783.223
9979	S 36-10- 0. W	51.650	9875	596.828	752.742
9875	S 36-10- 0. W	45.000	9978	560.500	726.186
9976	S 90- 0- 0. W	209.550	9873	491.072	379.887
9873	S 89-59-59. W	6.000	9975	491.072	373.887
9975	S 90- 0- 0. W	270.000	9974	491.072	103.887

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
1801	S 0- 0- 0. E	300.900	1802	1119.759	1337.001
1802	N 89-55-23. W	180.001	1803	1120.000	1157.000
1804	S 36-10- 0. W	98.344	1805	942.989	906.688
1805	N 51-13- 0. W	322.053	1806	1144.715	655.641
1810	S 51-13- 0. E	329.358	1811	813.820	812.267
1811	S 36-10- 0. W	255.306	1812	607.710	661.602
1813	S 89-59-59. W	485.021	1814	571.070	104.415
1815	S 89-59-59. E	486.079	1816	411.073	589.437
1817	N 36-10- 0. E	513.650	1818	927.961	1093.893
1819	S 89-55-23. E	180.001	1820	959.759	1337.001
1820	S 0- 0- 0. W	860.006	1821	99.753	1337.000

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
1502	S 89-49-47. W	603.729	1103	98.108	783.274
1103	S 89-49-47. W	82.000	1009	97.865	701.274
1009	S 89-49-47. W	324.000	909	96.902	377.276
909	S 89-49-46. W	276.000	9988	96.081	101.277
9988	N 0-22-43. E	365.000	92	461.073	103.609
92	N 90- 0- 0. E	275.999	91	461.073	379.688
91	S 0-22-46. W	364.179	909	96.902	377.276
91	S 89-59-59. E	209.749	109	461.073	589.437
110	S 11-14-35. E	374.216	1009	97.865	701.274
1103	N 37-17-24. E	339.666	1102	368.340	989.060
1102	S 53-50- 6. E	90.495	1407	314.936	1062.117
1407	N 89-49-46. E	324.884	1402	315.902	1387.000
1502	N 0- 0- 0. W	216.000	1402	315.902	1387.000
1402	N 0- 0- 0. W	575.000	1302	890.902	1387.000
133	S 0- 0- 0. W	119.098	1302	890.902	1387.000
1302	S 37-17-24. W	285.285	1209	663.935	1214.161
1209	S 37-17-24. W	326.546	1109	404.141	1016.323
1102	N 37-17-24. E	45.000	1109	404.141	1016.323

********** DISTANCES & BEARINGS **********

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
1109	N 70-43- 1. W	309.857	111	506.467	723.849
1199	S 36-10- 0. W	45.000	111	506.467	723.849
111	N 36-10- 0. E	430.284	120	853.837	977.775
1209	N 51-13-23. W	303.218	120	853.837	977.775
120	N 36-10- 0. E	128.366	131	957.467	1053.528
132	N 90- 0- 0. E	230.000	133	1010.000	1387.000
10	N 0- 0- 0. E	350.804	101	1420.804	1387.000
101	S 89-59- 0. W	278.000	104	1419.995	1109.001
104	S 7-48-32. E	353.271	11	1070.000	1157.000
11	N 90- 0- 0. E	230.000	10	1070.000	1387.000
104	S 89-59- 0. W	333.000	205	1419.027	776.003
205	S 36- 0-33. W	80.000	200	1354.313	728.969
200	S 37-22-41. E	454.640	21	992.876	1005.090
21	S 36-10- 0. W	150.629	31	871.272	916.198
31	N 51-13- 0. W	394.476	32	1118.362	608.696
33	N 36- 0-33. E	239.573	200	1354.313	728.969
205	S 89-59- 0. W	666.000	9987	1417.089	110.005
9987	S 0-22-43. W	94.000	404	1323.091	109.384

DISTANCES & BEARINGS

POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	END POINT	END POINT COORDS. NORTH	EAST
404	S 65-41- 8. E	443.076	41	1140.658	513.160
51	S 36- 0-33. W	185.000	502	929.974	420.565
502	S 51-12-46. E	435.224	63	657.336	759.813
63	N 36-10- 0. E	205.000	62	822.834	880.790
62	N 51-13- 0. W	397.215	61	1071.640	571.153
502	N 89-48- 5. W	43.773	503	930.125	376.792
503	N 89-48- 4. W	270.000	504	931.062	106.794
404	S 0-22-43. W	392.037	504	931.062	106.794
504	S 0-22-43. W	410.000	61	521.071	104.085
61	N 90- 0- 0. E	270.000	73	521.072	374.085
73	N 0-22-45. E	409.063	503	930.125	376.792
73	N 89-59-59. E	215.351	72	521.073	589.437
71	N 36-10- 0. E	98.021	63	657.336	759.813

CURVE DATA

CURVE DEFINED PC	CC	BY: PT	RADIUS FT	CENTRAL ANGLE DEG.MIN.SEC.	ARC FT	CHORD FT	BEARING OF CHORD DEG.MIN.SEC.	TANGENT FT	DEFLECTION ANGLE PER FT OF ARC MIN.
9976	9977	9874	169.390	11-14-35.	33.239	33.186	N 84-22-42. E	16.673	10.147430486
9874	9977	9979	169.390	42-35-25.	125.914	123.035	N 87-27-42. E	66.026	10.147438684
9982	9983	9984	158.170	53-50- 0.	148.612	143.205	N 63- 4-59. E	80.302	10.867255197

CURVE DATA

CURVE DEFINED PC	CC	BY: PT	RADIUS FT	CENTRAL ANGLE DEG.MIN.SEC.	ARC FT	CHORD FT	BEARING OF CHORD DEG.MIN.SEC.	TANGENT FT	DEFLECTION ANGLE PER FT OF ARC MIN.
1803	9983	1804	238.170	53-50- 0.	223.777	215.636	S 63- 4-59. W	120.918	7.217005662
1818	9983	1819	78.170	53-50- 0.	73.446	70.774	N 63- 4-59. E	39.686	21.988921649
1806	9980	1807	100.000	39-43-24.	69.330	67.950	N 34- 7-45. W	36.124	17.188739708
1807	9980	1808	100.000	101-41-41.	177.451	155.093	S 75- 9-42. W	122.819	17.188739121
1808	9980	1809	100.000	78-18-19.	136.669	126.278	S 14-50-18. E	81.421	17.188739717
1809	9980	1810	100.000	34-10-32.	59.648	58.767	S 71- 4-43. E	30.741	17.188742731
1812	9977	1813	69.390	53-50- 0.	63.988	80.933	S 63- 4-59. W	45.383	19.228928852
1816	9977	1817	249.390	53-50- 0.	234.319	225.795	N 63- 5- 0. E	126.614	6.892308553

CURVE DATA

CURVE DEFINED PC	CC	BY: PT	RADIUS FT	CENTRAL ANGLE DEG.MIN.SEC.	ARC FT	CHORD FT	BEARING OF CHORD DEG.MIN.SEC.	TANGENT FT	DEFLECTION ANGLE PER FT OF ARC MIN.
11	9983	21	188.170	53-50- 0.	176.795	170.367	S 63- 4-59. W	95.533	9.134684270
131	9983	132	128.170	53-50- 0.	120.424	116.044	N 63- 4-59. E	65.071	13.410860636
32	9980	33	50.000	55-56-56.	48.825	46.908	N 25- 0-59. W	26.557	24.377452642
33	9980	41	50.000	101-41-41.	88.745	77.547	S 75- 9-42. W	61.410	34.377481198
41	9980	51	50.000	78-18-19.	68.334	63.139	S 14-50-18. E	40.710	34.377483272
51	9980	61	50.000	50-24- 4.	43.883	42.579	S 79-11-28. E	23.529	34.377482499
71	9977	72	139.390	53-50- 0.	130.967	126.202	S 63- 5- 0. W	70.768	18.331356992
109	9977	110	199.390	11-14-35.	39.126	39.063	N 84-22-42. E	19.626	8.620662595
110	9977	1199	199.390	42-35-25.	148.215	144.826	N 57-27-42. E	77.719	8.620663219

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********** STREET CENTERLINES FOR STATIONING **********
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START POINT NO.	HORIZONTAL LINE DATA: BEARING DEG MIN SEC-	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	END POINT COORDS. EAST	HORIZONTAL CURVE DATA: RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE ROAD							
9990	N 0- 0- 0. E	380.900	180- 0- 0.	9986	1040.000	1420.000			
9986	N 0- 0- 0. E	149.098	180- 0- 0.	1309	890.902	1426.000			
1309	N 0- 0- 0. E	574.902	180- 0- 0.	1409	316.000	1420.000			
1409	N 0- 0- 0. E	216.000	0- 0- 0.	9989	100.000	1426.000			
		TRAVERSE SHOR							
9986	S 90- 0- 0. W	33.000	180- 0- 0.	9985	1040.000	1397.000			
9985	S 90- 0- 0. W	230.000	153- 5- 0.	9984	1040.000	1157.000			
9984	S 63- 4-59 W	143.205	153- 5- 0.	9982	975.172	1029.309	158.170	53-50- 0.	148.612
9982	S 36-10- 0. W	127.000	180- 0- 0.	9976	872.644	954.362			
9976	S 36-10- 0. W	55.000	180- 0- 0.	9981	828.242	921.904			
9981	S 36-10- 0. W	235.000	20-12-43.	9979	638.526	783.223			

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********** STREET CENTERLINES FOR STATIONING **********
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START POINT NO.	HORIZONTAL LINE DATA: BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	END POINT COORDS. EAST	HORIZONTAL CURVE DATA: RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE SHOR							
9981	S 36-10- 0. W	235.000	180- 0- 0.	9979	638.526	783.223			
9979	S 36-10- 0. W	51.650	180- 0- 0.	9875	596.828	752.742			
9875	S 36-10- 0. W	45.000	156-42-17.	9978	560.500	726.186			
9978	S 57-27-42. W	123.035	153- 5- 0.	9874	494.323	622.463	169.390	42-35-25.	125.914
9874	S 84-22-42. W	33.186	174-22-42.	9976	491.073	589.437	169.390	11-14-35.	33.239
9976	S 90- 0- 0. W	209.550	180- 0- 0.	9873	491.072	379.887			
9873	S 89-59-59. W	6.000	180- 0- 0.	9975	491.072	373.887			
9975	S 90- 0- 0. W	270.000	12-14-47.	9974	491.072	103.887			
		TRAVERSE SHOT							
9981	N 51-13- 0. W	465.900	38-47- 0.	9980	1120.071	558.725			

LOTTING DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	END POINT COORDS. EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE 1							
104	N 89-50- 0. E	278.000	89-50- 0.	101	1420.804	1397.000			
101	S 0- 0- 0. W	350.804	90- 0- 0.	10	1070.000	1387.000			
10	S 90- 0- 0. W	230.000	97-48-32.	11	1070.000	1157.000			
11	N 7-48-32. W	353.271	82-21-28.	104	1419.995	1109.001			
AREA = 89011.03 FT**2			2.043412 ACRES						
PERIMETER = 1212.075 FT									
		TRAVERSE 2							
104	S 7-48-32. E	353.271	109- 6-28.	11	1070.000	1157.000			
11	S 63- 4-59. W	170.367	100-27-40.	21	992.876	1005.090	188.170	53-50- 0.	176.799
21	N 37-22-41. W	454.840	106-36-46.	200	1354.313	728.969			
200	N 36- 0-33. E	80.000	126-10-33.	205	1419.027	776.003			
205	N 89-50- 0 E	331.000	97-38-32.	104	1419.995	1109.001			
ARC AREA = -2341.620									
AREA = 114592.23 FT**2			2.630676 ACRES						
PERIMETER = 1327.910 FT									
		TRAVERSE 3							
200	S 37-22-41. E	454.840	106-27-19.	21	992.876	1005.090			
21	S 36-10- 0. W	150.629	87-23- 0.	31	871.272	916.198			
31	N 51-13- 0. W	394.476	154-47-59.	32	1118.362	608.696			
32	N 26- 0-59. W	46.908	117-58-28.	33	1160.517	588.121	50.000	55-56-56.	48.825
33	N 36- 0-33. E	239.573	73-23-14.	200	1354.313	728.969			
ARC AREA = -184.941									
AREA = 88767.20 FT**2			2.037814 ACRES						
PERIMETER = 1288.342 FT									

LOTTING DATA

START POINT NO.	BEARING DEG. MIN. SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG. MIN. SEC.	ARC FT
		TRAVERSE 4							
404	N 0-22-43 E	94.000	90-32-43.	9987	1417.689	110.005			
9987	N 89-50- 0. E	666.000	53-49-27.	205	1419.027	776.003			
205	S 36- 0-33. W	80.000	180- 0- 0.	200	1354.313	728.565			
200	S 36- 0-33. W	239.573	140-50-50.	33	1160.517	588.121			
33	S 75- 9-42. W	77.547	140-50-50.	41	1140.658	513.160	50.000	101-41-41.	88.745
41	N 65-41- 8. W	443.076	113-56- 9.	404	1323.091	109.384			
ARC AREA =		-994.582							
AREA =	118304.44 FT**2		2.715696 ACRES						
PERIMETER =	1611.395 FT								
		TRAVERSE 5							
404	S 65-41- 8. E	443.076	129- 9- 9.	41	1140.658	513.160			
41	S 14-50-18. E	63.139	129- 9- 9.	51	1079.624	529.330	50.000	78-18-19.	68.334
51	S 36- 0-33. W	185.000	125-48-38.	502	929.974	420.565			
502	N 89-48- 5. W	43.773	179-59-59.	503	930.125	376.792			
503	N 89-48- 4. W	270.000	89-49-13.	504	931.062	106.794			
504	N 0-22-43. E	392.037	66- 3-51.	404	1323.091	109.384			
ARC AREA =		-484.302							
AREA =	116530.59 FT**2		2.675174 ACRES						
PERIMETER =	1402.220 FT								

LOTTING DATA

START POINT NO.	HORIZONTAL LINE DATA — BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA — RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE 6							
63	N 51-12-46. W	435.224	92-46-41.	502	929.974	420.565			
502	N 36- 0-33. E	185.000	115-12- 1.	61	1079.624	529.330			
61	S 79-11-28. E	42.579	152- 1-32.	61	1071.640	571.153	50.000	50-24- 4.	43.983
61	S 51-13- 0. E	397.215	92-37- 0.	62	822.834	886.796			
62	S 36-10- 0. W	205.000	87-22-45.	63	657.336	759.813			
ARC AREA =		-136.424							
AREA =	88657.10 FT**2	2.035287 ACRES							
PERIMETER =	1266.421 FT								
		TRAVERSE 7							
503	S 89-48- 5. E	43.773	141-24-41.	502	929.974	420.565			
502	S 51-12-46. E	435.224	92-37-14.	63	657.336	759.813			
63	S 36-10- 0. W	98.021	153- 5- 0.	71	578.204	701.967			
71	S .1- 5- 0 W	126.202	153- 5- 0.	72	521.073	889.437	139.390	53-50- 0.	130.967
72	S 89-59-59. W	215.351	89-37-14.	73	521.072	374.085			
73	N 0-22-45. E	409.063	90-10-50.	503	930.125	376.792			
ARC AREA =		1284.937							
AREA =	103405.61 FT**2	2.373867 ACRES							
PERIMETER =	1332.358 FT								
		TRAVERSE 8							
503	S 0-22-45. W	409.063	90-22-45.	73	521.072	374.085			
73	S 90- 0- 0. W	270.000	89-37-16.	81	521.071	104.085			
81	N 0-22-43. E	410.000	90-10-47.	504	931.062	106.794			
504	S 89-46- 4. E	270.000	89-49-11.	503	930.125	376.792			
AREA =	110572.03 FT**2	2.538385 ACRES							
PERIMETER =	1359.063 FT								

LOTTING DATA

START POINT NO.	BEARING DEG. MIN. SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG. MIN. SEC.	ARC FT
			TRAVERSE 9						
909	S 89-49-46 W	276.000	89-27- 3.	9988	96.081	101.277			
9988	N 0-22-43. E	365.000	90-22-43.	92	461.073	103.689			
92	N 90- 0- 0. E	275.999	89-37-13.	91	461.073	379.688			
91	S 0-22-46. W	364.179	90-33- 0.	909	96.902	377.276			
AREA = 100623.26 FT**2 2.309992 ACRES									
PERIMETER = 1281.179 FT									
			TRAVERSE 10						
1009	S 89-49-47. W	324.000	89-27- 0.	909	96.902	377.276			
909	N 0-22-46. E	364.179	90-22-45.	91	461.073	379.688			
91	S 89-59-59. E	209.749	174-22-41.	109	461.073	589.437			
109	N 84-22-42. E	39.063	95-37-17.	110	464.899	628.312	199.390	11-14-35.	39.126
110	S 11-14-35. E	374.216	78-55-38.	1009	97.865	701.274			
ARC AREA = -24.985									
AREA = 104734.45 FT**2 2.395189 ACRES									
PERIMETER = 1311.270 FT									
			TRAVERSE 11						
1103	S 89-49-47. W	82.000	101- 4-22.	1009	97.865	701.274			
1009	N 11-14-35. W	374.216	111-17-43.	110	464.899	628.312			
110	N 57-27-42. E	144.826	21-17-42.	1199	542.756	750.405	199.390	42-35-25.	148.215
1199	S 36-10- 0 W	45.000	73- 6-59.	111	506.467	723.849			
111	S 70-43- 1. E	309.857	71-59-35.	1109	404.141	1016.323			
1109	S 37-17-24. W	45.000	180- 0- 0.	1102	368.340	985.060			
1102	S 37-17-24. W	339.666	127-27-36.	1103	98.108	783.274			
ARC AREA = -1323.690									
AREA = 92335.54 FT**2 2.119732 ACRES									
PERIMETER = 1343.953 FT									

LOTTING DATA

START POINT NO.	HORIZONTAL LINE DATA — BEARING DEG-MIN-SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA — RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE 12							
1209	S 37-17-24. W	326.546	108- 0-24.	1109	404.141	1016.323			
1109	N 70-43- 1. W	309.857	73- 6-59.	111	506.467	723.849			
111	N 36-10- 0. E	430.284	87-23-23.	120	853.837	977.775			
120	S 51-13-23. E	303.218	91-29-13.	1209	663.935	1214.161			
AREA =	113280.68 FT**2		2.600567 ACRES						
PERIMETER =	1369.905 FT								
		TRAVERSE 13							
1209	N 51-13-23. W	303.218	92-36-37.	120	853.837	977.775			
120	N 36-10- 0. E	128.366	153- 5- 0.	131	957.467	1053.526			
131	N 63- 4-59. E	116.044	153- 5- 0.	132	1010.000	1157.000	128.170	53-50- 0.	120.424
132	N 90- 0- 0. E	230.000	90- 0- 0.	133	1010.000	1387.000			
133	S 0- 0- 0. W	119.098	142-42-36.	1302	890.902	1387.000			
1302	S 37-17-24. W	285.285	88-30-47.	1209	663.935	1214.161			
ARC AREA =	1086.398								
AREA =	90022.96 FT**2		2.066643 ACRES						
PERIMETER =	1166.391 FT								

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********** LOTTING DATA **********
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START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA: RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
			TRAVERSE 14						
1302	S .0- 0- 0. E	575.000	90-10-13.	1402	315.902	1387.000			
1402	S 89-49-46. W	324.884	143-39-46.	1407	314.936	1062.117			
1407	N 53-50- 0. W	90.495	88-52-36.	1102	368.340	989.060			
1102	N 37-17-24. E	45.000	180- 0- 0.	1109	404.141	1016.323			
1109	N 37-17-24. E	326.546	180- 0- 0.	1209	663.935	1214.161			
1209	N 37-17-24. E	285.285	37-17-24.	1302	890.902	1387.000			
AREA =		123118.09 FT**2		2.826402 ACRES					
PERIMETER =		1647.209 FT							
			TRAVERSE 15						
1502	S 89-49-47. W	603.729	52-32-23.	1103	98.108	783.274			
1103	N 37-17-24. E	339.666	91- 7-23.	1102	368.340	989.666			
1102	S 53-50- 0. E	90.495	143-39-46.	1407	314.936	1062.117			
1407	N 89-49-46. E	324.884	89-49-46.	1402	315.902	1387.000			
1402	S 0- 0- 0. E	216.000	90-10-13.	1502	99.902	1387.000			
AREA =		115455.53 FT**2		2.650087 ACRES					
PERIMETER =		1574.774 FT							

LOTTING DATA

START POINT NO.	BEARING DEG.MIN-SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE	SHOR						
92	N 0-22-43. E	60.000	90-22-43.	81	521.671	104.085			
81	N 90- 0- 0. E	270.000	180- 0- 0.	73	521.072	374.085			
73	N 89-59-59. E	215.351	153- 5- 1.	72	521.073	585.437			
72	N 63- 5- 0. E	126.202	116-55- 0.	71	578.204	701.967	139.390	53-50- 0.	130.967
71	S 53-50- 0. E	60.000	63- 5- 0.	1199	542.756	750.405			
1199	S 63- 5- 0. W	180.525	153- 4-59.	109	461.073	599.437	199.390	53-50- 0.	187.341
109	N 89-59-59. W	209.749	179-59-59.	91	461.073	379.688			
91	S 90- 0- 0. W	275.999	89-37-16.	92	461.073	103.686			
ARC AREA =		-1284.937							
ARC AREA =		2629.176							
AREA =		38681.69 FT**2		0.888888 ACRES					
PERIMETER =		1409.406 FT							
		TRAVERSE	SHOR						
71	N 36-10- 0. E	98.021	180- 0- 0.	63	657.336	759.813			
63	N 36-10- 0. E	205.000	180- 0- 0.	62	822.834	880.790			
62	N 36-10- 0. E	60.000	180- 0- 0.	31	871.272	916.198			
31	N 36-10- 0. E	150.629	90- 0- 0.	21	992.876	1005.090			
21	S 53-50- 0. E	60.000	90- 0- 0.	131	957.467	1053.528			
131	S 36-10- 0. W	128.366	180- 0- 0.	120	853.837	977.775			
120	S 36-10- 0. W	430.284	0- 0- 0.	111	506.467	723.849			
111	N 36-10- 0. E	45.000	90- 0- 0.	1199	542.756	750.405			
1199	N 53-50- 0. W	60.000	90- 0- 0.	71	578.204	701.967			
AREA =		30818.98 FT**2		0.707507 ACRES					
PERIMETER =		1237.295 FT							

LOTTING DATA

START POINT NO.	HORIZONTAL LINE DATA — BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	EAST	HORIZONTAL CURVE DATA — RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		TRAVERSE SHOR							
10	S 90- 0- 0. W	230.000	153- 5- 0.	11	1070.000	1157.000			
11	S 63- 4-59. W	170.367	63- 5- 0.	21	992.876	1005.090	100.170	53-50- 0.	176.799
21	S 53-50- 0. E	60.000	116-55- 0.	131	957.467	1053.528			
131	N 63- 4-59. E	116.044	153- 5- 0.	132	1010.000	1157.000	120.170	53-50- 0.	120.424
132	N 90- 0- 0. E	230.000	90- 0- 0.	133	1010.000	1387.000			
133	N 0- 0- 0. W	60.000	90- 0- 0.	10	1070.000	1387.000			
ARC AREA =		2341.620							
ARC AREA =		-1086.398							
AREA =		22716.70 FT**2	0.521504 ACRES						
PERIMETER =		877.222 FT							
		TRAVERSE SHCT							
62	N 51-13- 0. W	397.215	168-49-19.	61	1071.640	971.153			
61	N 40- 2-19. W	90.148	36-49-30.	41	1140.658	913.160	50.000	128-42-23.	112.318
41	S 76-51-50. E	98.103	154-21-11.	32	1118.362	608.698	50.000	157-38-37.	137.570
32	S 51-13- 0. E	394.476	92-37- 0.	31	871.272	916.198			
31	S 36-10- 0. W	60.000	87-23- 0.	62	822.834	880.790			
ARC AREA =		1832.484							
ARC AREA =		2963.789							
AREA =		31172.59 FT**2	0.715624 ACRES						
PERIMETER =		1101.578 FT							

LOTTING DATA

START POINT NO.	BEARING DEG.MIN.SEC.	DISTANCE FT	INTERIOR ANGLE AT END POINT	END POINT NO.	END POINT COORDS. NORTH	END POINT COORDS. EAST	HORIZONTAL CURVE DATA RADIUS FT	CENTRAL ANGLE DELTA DEG.MIN.SEC.	ARC FT
		HORIZONTAL LINE DATA							
		TRAVERSE	SCLN						
101	S 0- 0- 0. W	350.804	179-59-59.	10	1070.000	1337.000			
10	S 0- 0- 0. E	60.000	180- 0- 0.	133	1010.000	1337.000			
133	S 0- 0- 0. W	119.098	180- 0- 0.	1302	890.902	1337.000			
1302	S 0- 0- 0. E	575.000	180- 0- 0.	1402	315.902	1337.000			
1402	S 0- 0- 0. E	216.000	89-49-47.	1502	99.902	1337.000			
1502	N 89-49-47. E	33.000	90-10-13.	9989	100.000	1420.000			
9989	N 0- 0- 0. E	216.000	180- 0- 0.	1409	316.000	1420.000			
1409	N 0- 0- 0. E	574.902	180- 0- 0.	1309	890.902	1420.000			
1309	N 0- 0- 0. E	149.098	180- 0- 0.	9986	1040.000	1420.000			
9986	N 0- 0- 0 E	380.900	89-50- 0.	9990	1420.900	1420.000			
9990	S 89-50- 0. W	33.000	90-10- 0.	101	1420.804	1387.000			
AREA =		43589.65 FT**2	1.000681 ACRES						
PERIMETER =		2707.601 FT							
		TRAVERSE	40AC						
9990	N 0- 0- 0. E	1320.900	90-10-13.	9989	100.000	1420.000			
9989	S 89-49-47. W	1318.730	89-27- 4.	9988	96.081	101.277			
9988	N 0-22-43. E	1321.037	90-32-43.	9987	1417.089	110.005			
9987	N 89-50- 0. E	1310.001	89-50- 0.	9990	1420.900	1420.000			
AREA =		1236190.96 FT**2	28.387466 ACRES						
PERIMETER =		5270.664 FT							

APPENDIX F

PRINTOUT OF VERTICAL ELEVATION AND DATA GRIDS

ELEVATION GRID

	17E	33E	50E	67E	83E	100E	117E	133E	150E	167E	183E	200E	217E	233E	250E	267E	283E	300E	317E	333E
567N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
533N	0	0	0	0	0	171	169	169	167	161	159	158	153	152	150	150	148	146	140	139
517N	0	0	0	0	0	169	168	165	162	160	159	158	152	150	149	148	147	144	139	139
500N	0	0	0	0	0	166	166	160	160	158	156	153	150	147	147	147	145	140	138	139
483N	0	0	0	0	0	160	161	159	157	155	152	150	149	147	145	143	141	137	136	136
467N	0	0	0	0	0	159	157	154	151	150	151	149	148	145	140	140	139	133	131	131
450N	0	0	0	0	0	153	154	152	150	150	149	146	144	141	140	139	137	130	129	129
433N	0	0	0	0	0	150	150	151	149	148	144	141	140	138	137	135	132	129	128	128
417N	0	0	0	0	0	149	147	145	144	142	140	140	139	135	131	131	129	126	125	125
400N	0	0	0	0	0	143	142	141	140	139	139	139	138	133	130	129	128	124	123	124
383N	0	0	0	0	0	140	139	136	135	135	137	138	136	132	130	129	126	122	120	120
367N	0	0	0	0	0	139	137	133	130	130	131	133	133	130	127	125	122	120	120	120
350N	0	0	0	0	0	135	132	130	130	129	130	130	129	126	122	120	119	119	118	119
333N	0	0	0	0	0	130	129	129	128	128	128	126	127	123	119	119	119	118	118	118
317N	0	0	0	0	0	129	127	125	122	122	123	120	119	117	117	118	119	118	118	118
300N	0	0	0	0	0	124	123	121	120	120	119	117	113	112	114	114	114	116	117	119
283N	0	0	0	0	0	120	121	120	119	119	117	113	109	110	111	110	110	112	118	119
267N	0	0	0	0	0	119	118	116	117	114	111	110	108	106	109	110	111	116	119	119
250N	0	0	0	0	0	118	113	114	112	110	109	109	106	105	106	110	113	117	119	119
233N	0	0	0	0	0	110	109	109	108	108	107	105	104	104	105	107	114	117	119	120
217N	0	0	0	0	0	109	108	105	104	103	102	100	102	104	106	110	117	118	120	121
200N	0	0	0	0	0	104	104	101	99	100	101	100	102	105	108	113	118	119	120	123
183N	0	0	0	0	0	100	99	98	98	99	100	102	105	108	109	113	118	119	120	124
167N	0	0	0	0	0	98	98	98	98	99	101	105	108	109	110	113	118	119	121	125
150N	0	0	0	0	0	96	98	99	100	100	102	106	109	110	110	112	118	120	122	127
133N	0	0	0	0	0	98	99	100	100	100	103	106	109	110	112	114	119	121	123	128
117N	0	0	0	0	0	99	99	101	101	102	105	108	109	111	116	118	120	122	125	129
100N	0	0	0	0	0	100	100	101	105	108	108	109	110	114	118	119	120	122	127	129
83N	0	0	0	0	0	100	100	103	107	109	109	110	111	116	119	119	120	121	128	129
67N	0	0	0	0	0	101	101	104	107	109	109	110	111	116	119	120	120	122	128	129
50N	0	0	0	0	0	101	102	104	107	108	109	110	111	116	118	120	121	123	127	130
33N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	350E	367E	383E	400E	417E	433E	450E	467E	483E	500E	517E	533E	550E	567E	583E	600E	617E	633E	650E	667E
367N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
350N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
333N	138	138	139	140	140	142	148	150	150	155	153	159	165	169	171	173	174	0	0	0
317N	138	138	138	139	141	143	146	149	152	154	156	162	168	169	170	172	173	0	0	0
300N	139	136	135	136	142	144	145	149	154	156	156	164	169	170	170	170	170	0	0	0
283N	135	134	135	135	140	143	145	149	153	155	158	166	169	169	169	169	170	0	0	0
267N	130	131	134	138	139	141	147	149	151	154	159	166	169	169	169	166	166	0	0	0
250N	129	130	134	138	143	144	149	150	150	151	155	163	167	168	165	160	157	0	0	0
233N	128	129	132	136	140	145	149	150	150	150	152	157	162	161	158	152	151	0	0	0
217N	128	129	130	134	139	141	145	149	150	150	150	152	154	154	151	150	150	0	0	0
200N	127	129	130	133	138	139	140	147	149	150	150	150	150	148	148	149	150	0	0	0
183N	125	129	129	130	133	138	138	142	146	149	149	148	145	144	145	146	148	0	0	0
167N	123	126	128	129	130	132	134	138	141	145	145	143	142	139	141	143	145	0	0	0
150N	120	121	122	126	128	130	130	135	138	138	136	137	139	139	140	141	144	0	0	0
133N	119	120	120	121	126	128	129	131	130	131	132	137	139	139	140	142	144	0	0	0
117N	118	118	119	120	121	123	126	127	128	129	130	136	139	139	142	143	145	0	0	0
100N	118	118	118	120	120	120	123	128	126	127	131	135	139	140	145	148	148	0	0	0
83N	119	118	119	121	121	123	127	130	130	131	134	137	140	143	149	149	150	0	0	0
67N	119	119	120	123	127	129	131	134	139	138	141	144	144	148	151	150	153	0	0	0
50N	119	121	122	126	129	129	130	135	138	142	148	149	151	153	154	156	159	0	0	0
33N	121	123	125	129	130	131	132	137	140	147	149	150	154	157	157	158	159	0	0	0
17N	125	127	130	133	135	134	138	141	143	150	151	154	158	159	159	159	160	0	0	0
0N	128	129	130	135	138	139	145	148	149	152	154	157	159	159	160	162	163	0	0	0
17S	129	130	130	136	139	140	146	149	150	155	158	159	160	160	162	166	168	0	0	0
33S	130	130	132	138	140	140	147	150	152	157	159	160	161	163	165	169	169	0	0	0
50S	131	132	137	141	143	144	148	152	154	159	159	161	164	168	168	170	170	0	0	0
67S	132	136	141	146	148	149	151	156	157	160	161	164	168	169	170	172	171	0	0	0
83S	132	136	142	147	149	149	153	159	159	160	163	167	169	170	170	175	177	0	0	0
100S	130	134	140	145	147	149	153	158	160	161	164	168	170	170	173	178	179	0	0	0
117S	130	132	139	141	141	144	154	158	160	164	168	169	172	175	177	179	179	0	0	0
133S	130	132	139	140	140	141	154	159	160	166	169	170	175	178	179	180	181	0	0	0
150S	131	134	138	141	141	145	156	159	160	166	169	170	176	179	180	182	184	0	0	0
167S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
183S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DATA GRID

	17E	33E	50E	67E	83E	100E	117E	133E	150E	167E	183E	200E	217E	233E	250E	267E	283E	300E	317E	333E
867N																				
850N																				
833N						ML	ML	ML	ML	ML	ML	ML	ML	ML	CL	CL	CL	CL	CL	CL
817N						ML	ML	ML	ML	ML	ML	ML	ML	CL	CL	CL	CL	CL	CL	CL
800N						ML	ML	ML	ML	ML	ML	ML	ML	CL	CL	CL	CL	CL	CL	CL
783N						ML	ML	ML	ML	ML	ML	ML	ML	CL	CL	CL	CL	CL	CL	CL
767N						ML	ML	ML	ML	ML	ML	ML	ML	CL	CL	CL	CL	MLCL	MLCL	MLCL
750N						ML	ML	ML	ML	ML	ML	ML	ML	CL	CL	CL	CL	MLCL	MLCL	MLCL
733N						ML	ML	ML	ML	ML	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL
717N						ML	ML	ML	ML	CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL
700N						ML	ML	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL
683N						ML	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL
667N						ML	ML	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL
650N						CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL
633N						CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL
617N						CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL
600N						CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL
583N						CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	MLCL
567N						CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL
550N						CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL
533N						CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	CL
517N						MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	CL
500N						MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL
483N						MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL	CL	CL	CL
467N						MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL	CL	CL	CL	CL
450N						MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
433N						MLCL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
417N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
400N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
383N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
367N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
350N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
333N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
317N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
300N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
283N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
267N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
250N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
233N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
217N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
200N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
183N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
167N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
150N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
133N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
117N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
100N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
83N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
67N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
50N						CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
33N																				
17N																				

	350E	367E	383E	400E	417E	433E	450E	467E	483E	500E	517E	533E	550E	567E	583E	600E	617E	633E	650E	667E
567N																				
550N																				
533N	CL	CL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML			
517N	CL	CL	MLCL	MLCL	MLCL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML			
500N	CL	CL	MLCL	MLCL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML			
483N	CL	MLCL	MLCL	MLCL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML			
467N	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML			
450N	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML			
433N	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML			
417N	MLCL	MLCL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML			
400N	MLCL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	CL	CL	CL	CL			
383N	MLCL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	MLCL	MLCL	CL	CL			
367N	MLCL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL			
350N	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL			
333N	CL	CL	CL	CL	CL	CL	CL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL			
317N	MLCL	MLCL	CL	CL	MLCL	MLCL	CL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL			
300N	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL			
283N	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	MLCL	CL	CL	CL	CL			
267N	MLCL	MLCL	MLCL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL			
250N	CL	MLCL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML			
233N	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML			
217N	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML			
200N	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML			
183N	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML			
167N	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML			
150N	CL	CL	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML			
133N	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML			
117N	CL	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML			
100N	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML			
83N	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML			
67N	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML			
50N	CL	CL	CL	CL	CL	CL	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML	ML			
33N																				
17N																				

APPENDIX G

PRINTOUT OF FLOOD PLAIN ELEVATION AND DATA GRIDS

ELEVATION	GRID 200E	300E	400E	500E	600E	700E	800E	900E	1000E	1100E	1200E	1300E	1400E	1500E	1600E	1700E	1800E	1900E	2000E	2100E
3400N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3300N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3200N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3100N	0	0	0	0	676	660	654	661	670	671	670	670	670	670	671	679	693	694	686	683
3000N	0	0	0	0	668	665	668	669	670	671	670	670	670	670	671	673	677	679	684	687
2900N	0	0	0	0	654	668	674	673	671	671	670	670	670	669	669	669	670	671	683	689
2800N	0	0	0	0	656	667	672	672	671	670	670	670	669	669	669	669	670	674	684	690
2700N	0	0	0	0	654	665	671	671	670	670	669	668	668	667	667	668	671	673	688	698
2600N	0	0	0	0	654	666	672	670	669	669	668	667	667	667	667	669	671	674	692	699
2500N	0	0	0	0	661	660	661	663	668	668	667	666	666	667	668	671	678	684	702	712
2400N	0	0	0	0	667	656	650	659	668	669	666	664	664	666	667	673	684	686	710	729
2300N	0	0	0	0	670	662	655	660	666	665	663	663	663	665	668	676	686	692	712	726
2200N	0	0	0	0	685	677	673	668	659	658	656	654	657	665	670	679	693	700	715	726
2100N	0	0	0	0	689	683	679	674	657	656	655	650	654	665	670	679	698	700	717	729
2000N	0	0	0	0	696	692	688	683	672	666	661	658	657	660	668	676	692	698	710	716
1900N	0	0	0	0	706	706	708	698	688	686	671	667	657	655	660	672	688	691	701	701
1800N	0	0	0	0	709	710	709	704	692	687	671	667	657	655	660	672	688	692	702	701
1700N	0	0	0	0	711	716	717	710	697	686	668	659	658	661	668	676	693	700	717	727
1600N	0	0	0	0	707	721	728	718	699	695	660	657	659	666	672	681	699	701	729	749
1500N	0	0	0	0	705	716	721	711	695	684	664	658	660	667	673	683	697	707	731	748
1400N	0	0	0	0	699	704	706	697	682	674	666	663	664	668	673	683	698	707	739	761
1300N	0	0	0	0	694	700	704	691	674	671	665	664	665	670	672	685	701	704	746	769
1200N	0	0	0	0	685	685	686	679	670	666	661	661	664	668	678	690	714	727	747	760
1100N	0	0	0	0	672	671	666	669	665	663	654	659	662	669	675	700	741	748	753	759
1000N	0	0	0	0	669	667	665	666	664	662	654	658	663	672	677	708	744	749	756	759
900N	0	0	0	0	680	666	667	665	663	660	656	654	663	688	707	720	742	750	755	757
800N	0	0	0	0	661	667	669	667	662	661	654	650	664	704	719	728	748	749	754	759
700N	0	0	0	0	662	665	667	665	662	663	664	670	682	710	716	726	741	744	748	751
600N	0	0	0	0	663	663	663	663	661	661	669	712	716	709	712	721	731	733	732	730
500N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
400N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DATA GRID

	200E	300E	400E	500E	600E	700E	800E	900E	1000E	1100E	1200E	1300E	1400E	1500E	1600E	1700E	1800E	1900E	2000E	2100E
3400N																				
3300N																				
3200N																				
3100N					DRRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRUR
3000N					DRUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRRL	DRRL
2900N					DRUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRRL	DRRL
2800N					DRUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRRL	DRRL
2700N					FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRRL	DRRL
2600N					FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRRL	DRRL
2500N					FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRUR
2400N					FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRUR
2300N					FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRUR
2200N					DRUR	FLUR	FLUR	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLUR	FLUR	FLUR	DRUR	DRUR	DRUR	DRUR
2100N					DRUR	FLUR	FLUR	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLUR	FLUR	FLUR	DRUR	DRUR	DRUR	DRUR
2000N					DRUR	FLUR	FLUR	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLUR	FLUR	FLUR	DRUR	DRUR	DRUR	DRUR
1900N					DRUR	DRUR	DRUR	DRUR	DRUR	DRUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRUR
1800N					DRUR	DRUR	DRUR	DRUR	DRUR	DRUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRUR
1700N					DRUR	DRUR	DRUR	DRUR	DRUR	DRUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	DRUR	DRUR
1600N					DRUR	DRUR	DRUR	DRUR	DRUR	DRUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	DRUR	DRUR
1500N					DRUR	DRUR	DRUR	DRUR	DRUR	DRUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	DRUR	DRUR
1400N					DRUR	DRUR	DRUR	DRUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	DRUR	DRUR
1300N					DRUR	DRUR	DRUR	DRUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	DRUR	DRUR
1200N					DRUR	DRUR	DRUR	DRUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	DRUR	DRUR
1100N					FLUR	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	FLUR	DRUR	DRUR	DRUR	DRUR
1000N					FLUR	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	FLUR	FLUR	FLUR	DRUR	DRUR	DRUR	DRUR
900N					FLRL	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRRL	DRRL	DRUR	DRUR
800N					FLRL	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRRL	DRRL	DRUR	DRUR
700N					FLRL	FLUR	FLUR	FLUR	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRRL	DRRL	DRUR	DRUR
600N					FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	FLRL	DRUR	DRUR	DRUR	DRUR	DRUR	DRRL	DRRL	DRUR	DRUR
500N																				
400N																				
300N																				
200N																				
100N																				

VITA

Frank William Pickell

Candidate for the Degree of

Master of Science

Thesis: COMPUTER METHOD FOR SUBDIVISION PLANNING, DESIGN, AND MAPPING

Major Field: Civil Engineering

Biographical:

Personal Data: Born in Oklahoma City, Oklahoma, March 27, 1956, the son of Mr. and Mrs. M. W. Pickell.

Education: Attended the Bartlesville Public Schools; graduated from Sooner High School, Bartlesville, Oklahoma, in May, 1974; received the Bachelor of Science in Civil Engineering degree from Oklahoma State University in July, 1978; entered graduate school, Oklahoma State University, in September, 1978, and completed requirements for the Master of Science degree in July, 1979.

Professional Organizations: Chi Epsilon Civil Engineering Honorary Fraternity; American Society of Civil Engineers; Associated General Contractors.